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The Thirty-second Annual Report

of the

Maryland State College  
of Agriculture

Agricultural Experiment Station



College Park, Prince George County, Maryland

1918-1919

Published by the Station

# The Maryland Agricultural Experiment Station

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The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C.  
Bell Telephone—Berwyn Exchange.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

### ADDRESS:

AGRICULTURAL EXPERIMENT STATION,  
College Park, Md.

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THE  
Maryland State College of Agriculture  
AGRICULTURAL EXPERIMENT STATION

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Volume 32

1918-1919

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The Thirty-Second Annual Report of the Maryland  
Agricultural Experiment Station

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FOR THE FISCAL YEAR ENDING JUNE 30, 1919.

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BY H. J. PATTERSON, Director.

*To the President and Board of Trustees:*

GENTLEMEN:—In accordance with the requirements of the Act of Congress providing for the establishment of Agricultural Experiment Stations, I transmit herewith the following report covering the work and expenditures of the Maryland Agricultural Experiment Station for the fiscal year ending June 30, 1919.

PUBLICATIONS.

The results of the investigations conducted by the station are published in bulletin form. The bulletins are issued at irregular intervals or whenever the results are completed or have progressed far enough to be of value or interest to the public. Usually eight or ten bulletins are issued each year.

The bulletins are sent free to all farmers in Maryland who desire them. There are about twenty thousand names on the station general mailing list. In addition to the general list the station has lists of

farmers engaged in growing specific crops so as to be able to communicate or send them information on special subjects.

The following bulletins were issued during this fiscal year:

	<i>Date.</i>	<i>No.</i>	<i>Subject.</i>	<i>Author.</i>	<i>No. Pages</i>
Aug. ....	1918	219	The Revised Agricultural Seed Law .....	C. P. Smith	9
Sept. ....	1918	220	Agricultural Seed Inspected in 1917 .....	C. P. Smith	54
Sept. ....	1918	221	An Accurate Method of Determining Which Hens Are Laying .....	R. H. Waite	19
Sept. ....	1918	222	Experiments With Fertilizers on Greenhouse Crops ....	T. H. White	28
Oct. ....	1918	223	A Comparison of Several Species of Lepidoptera Infesting Peach and Apple in Maryland, With Additional Notes on the Oriental Peach Moth .....	P. Garman	25
Dec. ....	1918	224	Seed Inspected in March and April, 1918 .....	C. P. Smith	29
Jan. ....	1919	225	Fertilizer Experiments With Tobacco .....	W. W. Garner & D. E. Brown	28
Feb. ....	1919	226	How to Caponize .....	R. H. Waite	9
March ...	1919	227	Citrus Fruit Rinds as a Hog Feed .....	R. S. Allen	10
June ....	1919	—	32nd Annual Report .....	H. J. Patterson	—

A total of 9 bulletins and the annual report, making a volume of 202 pages for the year. In addition to the official bulletins, the members of the station staff have contributed numerous articles of a popular nature to the agricultural papers and the following articles to the scientific journals.

Status of the Oriental Peach Moth; *Journal of Economic Entomology*, Vol. 12, No. 1, pages, 81-83. E. N. Cory.

Life History of the Oriental Peach Moth; *Peninsula Horticultural Society Report*, 1919. E. N. Cory.

Report on the Insects of the Year; *Peninsula Horticultural Society Report*, 1919. E. N. Cory.

Black Leg in an Aged Cow; *Cornell Veterinarian*, Vol. IX., No. 2, page 124. E. M. Pickens.

Paralysis in the Hind Quarters of a Sow Due to Kidney Worms; *Cornell Veterinarian*, Vol. IX., No. 2, page 124. E. M. Pickens and C. C. Shivers.

The Relation of Time of Blooming to Ripening Period in Peach Varieties; *Proc. Amer. Soc. Hort. Sci.* 15: 66-67, 1919. J. B. S. Norton.

Hot Water Seed Treatment for Black Leg of Cabbage; *Phytopathology* 9: 50-51, 1919. J. B. S. Norton.

Commelinaceae and Euphorbiaceae in Flora of the District of Columbia and Vicinity. Contrib. U. S. Nat. Herb. 21: 115-116, 194-197, 1919. J. B. S. Norton.

Germination of Immature Seeds; Journ. Wash. Acad. Sci. 9: 146-147, 1919. J. B. S. Norton.

Abnormal Stem Growth of Soy Beans in Sand Cultures with Shive's Three-salt Solution. Soil Science 6: 479-481, 1919. A. G. McCall, J. B. S. Norton and P. E. Richards.

Respiration and Catalase Activity in Sweet Corn; Amer. Jour. of Bot. 5: 207-209, 1918. Chas. O. Appleman.

Special Growth Promoting Substances and Correlation; Science 68: 319-320, 1918. Chas. O. Appleman.

Carbohydrate Metabolism in Green Sweet Corn During Storage at Different Temperatures; Jour of Agr. Res., 1919. Chas O. Appleman and John M. Arthur.

A Simple Non-Absorbing Atmometer Mounting; Plant World, 1918. E. S. Johnston.

An Index of Hardiness of Peach Buds; Amer. Jour. Bot. E. S. Johnston.

Nutrient Requirement of Potato Plant; Plant World. E. S. Johnston.

#### STAFF PERSONNEL.

E. H. Brinkley, who had been farm superintendent for many years, was given a leave of absence for 14 months to do special war work for the U. S. Grain Corporation as inspector of threshing outfits and for the U. S. Department of Agriculture as labor specialist. At the end of this period he resigned to engage in commercial work.

A. R. Ward, D. V. M., resigned at the end of three months service to enter commercial work.

E. M. Pickens, D. V. M., of Cornell University, was appointed animal pathologist to succeed A. R. Ward.

Geo. R. Stuntz, B. S., Maryland State College, was appointed assistant agronomist to succeed W. J. Aitcheson who resigned to engage in farming for himself.

C. P. Smith, seed inspector, resigned to accept a position in commercial work with W. G. Searlett & Co., Baltimore. He was succeeded by the appointment of F. S. Holmes, who was formerly connected with the station, but who resigned to enter the army at the beginning of the war with Germany.

C. L. Opperman, superintendent of Ridgely farm, was transferred to the Extension Department, and he was succeeded by Albert White, B. S., a graduate of this college, class of 1914.

John Paul Jones, of the class of 1918, was appointed an assistant in the plant physiology department.

## LOCATION OF STATION WORK.

An examination of the program of work in progress shows that in addition to the work carried on at College Park a considerable amount is located in different parts of the state. This has been found desirable in order to obtain the conditions of soil, environment, etc., necessary to solve the problems to best advantage. The location of investigations in different sections of the state and in communities interested in producing the particular crop under consideration not only provides the most satisfactory conditions, but also makes the growers more interested and sympathetic with the results obtained.

The location of investigational work on private farms not only secures the interest of the local communities, but the work is less likely to be interfered with or depredated upon than when located at the home institution on public property. Unfortunately, some people regard the state property public to the extent that all residents of the state may help themselves to the products. This attitude has caused many results to be lost or made worthless.

The policy of distributing investigational work in different parts of the state has been found satisfactory and to have the following advantages:

1. It enables the selection of the most ideal conditions that it is possible to obtain.
2. Enables the elimination of the influence of previous tests that may have been conducted on the same land.
3. Enables the work to be isolated and removed from undesirable influences to as great an extent as possible.
4. Makes it possible to conduct the tests and check up results under a wider range and variety of conditions.
5. Secures the interest and sympathy of the local community and the farmers specially interested in a particular crop.
6. Reduces the liability of loss of results through the depredation on products to a minimum.
7. Relieves the institution of the marketing of products or becoming the competitor of private capital.
8. The work can be conducted as economically as at the central institution.
9. Enables the expansion of the investigational work without owning or investing money in land, teams and equipment. The success

of the work, however, will be dependent upon the careful selection of the colaborator and the giving of sufficient supervision at the critical periods.

### THE PRESENT AND FUTURE OF INVESTIGATIONAL WORK.

The character and results of the work of the Experiment Station are largely responsible for the present popularity of the College and its various departments with the farmers of this State. As the investigational work of the country developed agriculture was given matter to teach and the subject was reduced to a teachable form and then the land grant colleges took on the real functions for which they were created. The Experiment Station work made necessary the calling into existence of the Extension Department which in a large measure is its agency for carrying the results of the investigations out and demonstrating their application to the farmers. The Experiment Stations in a measure have been the munition factories for the other branches of the institutions. The creation of the extension departments relieved the stations of the work and expense of conducting their own demonstrations and doing many things which could not truly be classed as investigations, but at the same time it took the stations out of that intimate personal touch with the farmers which has obtained in the past. This to some extent has been to the disadvantage of the station especially in the matter of appropriations for investigational work. The fact that the states are required to make large appropriations in order to offset the federal funds for extension work has also made it more difficult to get increased amounts for other phases of work as in the smaller states the amount necessary for the extension departments represented a large increase over the allotment given the institutions in former years by the state legislatures.

The Experiment Station in common with most state institutions has found that the great shrinkage in the purchasing power of the dollar has made it impossible to continue all the work conducted in the past or to meet the constantly increasing demands made for help or to take up the many new problems which present themselves from time to time. The circumscribed uses which can be made of appropriations under the present system also makes conditions more difficult as it is not possible to economize to any extent in one direction so as to apply the funds to the channels where they would be of most help or would meet emergencies which arise. The most economical and effi-



cient administration of an institution for research necessitates considerable latitude in the use of appropriations for both maintenance and salaries.

The problem of providing for the decreased purchasing power of the dollar and equalizing salaries of specially trained scientific men so as to enable them to live and meet the demands made of them are matters which deserve the serious consideration and prompt action of the legislature so as to prevent the decadence of agricultural research and enable the Experiment Station to do the work required and expected properly.

The future of the Experiment Station work depends upon an increase in appropriations to maintain the investigations now in progress and provide additional funds for solving the new problems. The increases in the yields and quality of corn, wheat, potatoes, hay and tobacco and orchard fruits which have been brought about as a result of the station's work amounts annually to more than five million dollars. The amount which the State should appropriate to continue to maintain the investigational work on the past basis would amount to a commission of only about one per cent. on this annual increase in farm sales that is enjoyed by Maryland farmers.

*Soil Work.*—The soil and fertility investigations has such an intimate bearing upon all other lines of work that it would seem very desirable to expand it at least enough to include all of the principle soil types. The work now being pursued was provided for by an appropriation made by the legislature of 1912. Instead of spending all the money in one biennium it was decided to map out a program to cover a period of five or six years. This appropriation is now about expended and it will be necessary for the legislature of 1920 to provide for its continuation. Enough should be provided to make it possible to locate field tests, similar to those described on page xvii, on all of the soil types of agricultural importance in the State and locate some work in each county.

The soil surveys are being made in cooperation with the U. S. Department of Agriculture and the State Geological Survey. It will take about two more summers to complete the survey of the State. Maryland should take special pride in the soil survey work as it was first inaugurated in this State and will probably be the first State to have surveys for every county.

## BUILDINGS.

The present Station buildings do not provide as much room or as good facilities as are desirable for the work in hand. A new, modern and well equipped building should be provided for investigational work. The present buildings need painting and considerable repairs. Money must be provided for this purpose as the present budget allows nothing for repairs. There should also be an appropriation for the insurance on the buildings unless the State should make some provision to carry its own insurance on all State buildings.

## PROGRAM OF INVESTIGATIONS IN PROGRESS.

On the following pages will be found a list of the investigations in progress and a brief statement of the object sought and results obtained up to this time. A study of these will show that the subjects cover a wide range and aim to give information which will contribute to the successful production of the principle crops grown in Maryland. It will also be noted that the investigations are conducted at a large number of points in the State and at the places furnishing the best conditions and where the results will be of most value and interest.

## SOIL AND FERTILITY INVESTIGATIONS.

*Project 1.*—An investigation of the food requirements of plants growing in sand and soil cultures.

*Object.*—To determine under controlled conditions the mineral food requirements of the different crop plants at different growth periods.

*Procedure.*—A large number of pot cultures are grown in pure quartz sand and supplied at frequent intervals with nutrient solutions. Each culture of a given series is supplied with a solution of the same total concentration, but differing from all others of the series with respect to the proportion of the salts used. At the end of definite growth periods the plants are harvested and from the dry weights it is possible to determine the best proportion of nutrient salts for a particular growth period.

*Cooperation.*—During the past year the work as outlined has been taken up by the National Research Council with a view to securing nation-wide cooperative research on the salt requirements of representative agricultural plants.

*Location.*—College Park, Md.

*Date begun.*—June 1, 1916.

*Results.*—Working with wheat, buckwheat and soy beans, the best proportion of nutrient for these different classes of plants has been determined for the first thirty days of their growth period. For spring wheat results have been obtained for two additional periods, the last period ending with the maturing of the plant. From the results obtained it would appear that the mineral food requirements of the wheat plant during the second growth period are substantially the same as for the first thirty-day period. Results for the final growth period indicate that there is an increase in the physiological requirements for magnesium during the late stages in the development of the wheat plant. During the first growth period the proportion of nutrient salts that gave the highest growth rate for wheat, also gave the highest growth rate for soy beans. Recent results strongly suggest that the physiological properties of a solution are not determined solely by the ionic proportions but are conditioned as well upon the molecular combinations that may exist in the nutrient solution. It is expected that the final results will throw important light upon the fundamental principles of fertilizer practice on the farm, and at the same time make a real contribution to our knowledge of the physiology of some important crop plants. Preliminary papers have been published by this department in *Soil Science*, *Journal of the American Society of Agronomy* and in the *Proceedings of the Society for the Promotion of Agricultural Science*.

*Persons Engaged.*—A. G. McCall and P. E. Richards.

*Project 2.*—A study of the hourly and daily fluctuation in the temperature of the soil.

*Object.*—To obtain a simultaneous record of the temperature of the soil at different depths under bare and under cropped surfaces.

*Procedure.*—Thermograph bulbs have been buried in the soil at the desired depths and connected by means of flexible tubes to a self-recording thermograph. A similar bulb, suspended above the surface of the soil and connected to one of the instruments, is used to record the variations in the air temperature. The bulbs are located in the soil at depths of 3, 6, and 24 inches below the surface of bare soil and at the same depths below a blue grass sod, both soils being in close proximity and of the same type.

*Cooperation.*—The data obtained will be used by other departments as an aid in the study of the factors affecting the spindling sprout diseases of potatoes and the resistance of tomatoes to wilt and blight. Members of the Ecological Society of America and of the Phytopathological Society



are cooperating in recording simultaneous variations in soil temperatures at thirty or forty different stations in the United States and in Canada.

*Location.*—College Park, Md.

*Date begun.*—January, 1917.

*Results.*—Continuous simultaneous records covering a period of two years have been secured showing the hourly and daily fluctuation of the soil temperature at 3, 6, and 24 inches below a bare surface and at corresponding depths below a blue grass sod.

The total production of wheat in Maryland is very materially reduced each year by the fact that a great many acres are abandoned every spring as the result of winter-killing of the plants. A still larger acreage fails to produce a profitable crop by reason of the thin stand resulting from winter-killing.

Common observations in the field lead to the conclusion that severe winter-killing and the poor development of the wheat plant in the spring is frequently the result of late fall seeding, which prevents the crop from making sufficient growth to furnish winter protection to the soil and to the roots of the young plants.

As the result of this study of soil temperatures it has been found that during very severe periods of cold weather when the ground was covered with snow, there was a very marked difference in the temperature of bare and of cropped soil. On December 30th, 1917, with the air temperature 12 degrees below zero, the temperature at a depth of 3 inches under cropped soil was 31 degrees and at the same depth under bare soil the temperature went down to 22 degrees. On January 1, 1918, with an air temperature 8 degrees below zero the temperature under cropped soil was 30 degrees, and under bare soil surface 21 degrees. From these figures it will be seen that the soil covered with plants and protected with a blanket of snow maintained a temperature 38 to 43 degrees above the surrounding air and 9 degrees above the bare soil which was similarly protected by the covering of snow.

It is evident, therefore, that wheat seeded sufficiently early to make a good growth before severe weather will have a much better chance to survive than wheat seeded late and which has not had sufficient time to develop a protective covering.

*Persons engaged.*—A. G. McCall.

*Project 3.*—The effect of green manuring upon the activity of micro-organisms in the soil.

*Object.*—To study the effect of different classes of green manuring crops upon the bacteria of the soil, with special reference to the maintenance of the nitrogen supply without resorting to the purchase of commercial nitrogen.

*Procedure.*—For this project use is made of the green-manuring plots at the Branchville Sub-station. The plots receiving different treatments are studied with respect to the number and kind of bacteria found at different depths and at different times of the year. These organisms are then isolated and studied in the laboratory for the purpose of determining their power to obtain nitrogen from the soil, air and from the organic matter of the soil.

*Location.*—Branchville, Maryland, and College Park, Maryland.

*Date begun.*—January, 1917. Suspended September 1, 1918.

*Results.*—The resignation of Dr. Paul Emerson, as soil bacteriologist, has caused a temporary suspension of this work. A report of the results obtained by Dr. Emerson is being prepared, but sufficient data to warrant any conclusions has not been assembled.

*Persons engaged.*—Paul Emerson.

*Project 4.*—An investigation of the factors affecting the availability of the potassium compounds of the soil.

*Object.*—To study the effect of different treatments upon the liberation of potassium from soil minerals, with a view of making available a portion of the enormous amount of potassium that exists in an unavailable form in practically all the soils.

*Procedure.*—Representative samples of important soil types are treated with different fertilizing materials and amendments and the water extracts analyzed for potassium. Other materials (such as green sand marl) rich in potassium are composted with sulfur, manure, etc., and determinations made of the amounts of potassium made available by the different treatments.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—Work on samples of soil from Branchville and from Frederick County have shown that the addition of lime in the form of calcium carbonate decreases the solubility of the soil potassium, while the addition of calcium oxide slightly increases the availability of potassium compounds. The addition of common salt, sodium chloride, very greatly increased the solubility of potassium, while gypsum or calcium sulfate had no appreciable effect. In another series of experiments green sand was composted with sulfur and manure in various combinations and supplied with solfofying bacteria. An analysis of the water extract from these composts was made from time to time over a period of 23 weeks. In certain of these composts it was found that more than 40 per cent. of the total potassium present in the mixture had been made water soluble. In the presence of a supply of organic matter the solfofying bacteria appear to promote the oxidation of the sulfur and the formation of sulfuric acid, which in turn acts upon the potash-bearing materials to liberate potassium.

*Persons engaged.*—A. G. McCall and A. M. Smith.

#### *Project 5.*—Calcium vs. magnesium limestone.

*Object.*—In certain sections of Maryland magnesium or dolomitic lime-available for agricultural purposes, the question often arises as to its stone is found in abundance, and since it is frequently in a form readily value in comparison with the ordinary calcium limestone. This project is intended to furnish information upon this point.

*Procedure.*—Large tile pots are sunk into the ground and filled with soil. In the first series of 24 pots the soil is treated with varying proportions of calcium and magnesium limestones and all seeded to the same crop. In a second series of pots the soil is treated with dolomitic stone of varying degrees of fineness. The first seeding was to wheat which is being followed by clover. The rate of movement of the limestone from the surface into the deeper layers of soil is also being studied.

*Location.*—College Park, Maryland.

*Date begun.*—1918.

*Results.*—Since only one crop has been harvested it is not possible to draw any conclusions at this time.

*Persons engaged.*—A. G. McCall, L. W. Erdman and A. M. Smith.

#### *Project 6.*—Pot culture studies of the fertilizer requirements of different soil types.

*Object.*—To study the effect upon yield of varying the proportions of nitrogen, phosphorus and potassium applied to some of the more important types of soil. The results will have a direct and very practical application to the purchase of fertilizers for use on these soils, of which there are large areas in the State.

*Procedure.*—Four types of soil are included in this project—Leonardtown silt loam, Collington sandy loam, Norfolk sand and Sassafra loam. A series of 24 tile pots are used for each soil type; every pot in the series is filled with the same kind of soil, but every pot differs from every other pot in the proportions of nitrate of soda, acid phosphate and muriate of

potash which it receives. In each series pot No. 1 receives a full treatment of acid phosphate; No. 2 receives 80 per cent. phosphoric acid, 20 per cent. nitrate; No. 3, 60 per cent. of phosphoric acid and 40 per cent. nitrate, etc., the variation being by 20 per cent. intervals and the pots being sufficient in number to provide for every possible combination of the three fertilizing materials. A three-year rotation of wheat, clover and corn will be grown in each series.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—One crop of wheat has been harvested, which gave the following results: For Leonardtown loam the seven pots giving the highest yields are those which receive on the average approximately one part each of nitrate and muriate to four parts of acid phosphate. For Collington sandy loam the best proportions were 1 part nitrate, 4 parts acid phosphate and 2 parts muriate. For Norfolk sand the proportions are 2 parts nitrate, 4 parts acid phosphate and 1 part muriate. For Sassafras loam the proportions are one part nitrate, 3 parts acid phosphate and 1.7 parts muriate. It remains to be seen to what extent these proportions will vary under different seasonal conditions.

*Persons engaged.*—A. G. McCall and L. W. Erdman.

*Project 7.*—(Branchville Project 1.)—Green manuring experiments.

*Object.*—To determine the relative value of crimson clover, hairy vetch, rye, red clover and alsike clover when used as green manuring crops. It was also proposed to determine if possible the best method of handling each of these crops.

*Procedure.*—The land is divided into two sections, upon one of which corn is grown every alternate year, while on the other section wheat is grown every other year and green manuring crops being seeded after the wheat is harvested, to be plowed down for corn. Twenty-one tenth-acre plots are included in each section, some of which are plowed after the fertilizing crop has grown to maturity, while on others the crops are plowed down at various stages of maturity. One-half of each plot is limed, while the other half receives no lime.

*Cooperation.*—Plots were laid out and work conducted by the Department of Agronomy until January, 1917.

*Location.*—Branchville.

*Date begun.*—1914.

*Results.*—The results have been inconsistent and disappointing because of the frequent failure of the legumes to make satisfactory growth when seeded after wheat. Rye has usually made good growth but the soil has failed to respond consistently.

*Persons engaged.*—N. Schmitz and W. E. Hanger 1914-17, A. G. McCall and L. W. Erdman since 1917.

*Project 8.*—(Branchville Project 2.)—Green manuring experiments.

*Object.*—To test different methods of handling cow peas and soy beans when used as a fertilizing crop for corn and to compare their value with that of buckwheat when used as a green manuring crop.

*Procedure.*—Same as for project 7, except that different fertilizing crops were employed.

*Cooperation.*—Work conducted by Department of Agronomy until January, 1917.

*Location.*—Branchville, Maryland.

*Date begun.*—1914.

*Results.*—While no striking increases in yield have been secured, the plots on which the green manuring crop was plowed down in the fall have been consistently better. On the average the increase in yield has not been sufficient to pay for the seed and for the extra labor involved in handling the green manuring crop.

*Persons engaged.*—N. Schmitz, W. E. Hanger, A. G. McCall and L. W. Erdman.

*Project 9.*—(Branchville Project 4.)—Phosphate experiments.

*Object.*—To compare the availability of the phosphorus in raw ground phosphate rock with that in acid phosphate when used in connection with green manures. In some sections of the United States the use of raw ground phosphate rock in preference to acid phosphate is being advocated because of the relative cheapness of the former. The relative effectiveness of the two carriers of phosphorus is, therefore, a matter of great practical importance to the farmers of Maryland, since phosphorus is used more extensively than any other fertilizing material sold in the state.

*Procedure.*—The project comprises two series of 23 plots each, upon which wheat and corn are grown alternatively with crimson clover seeded after the wheat and plowed down the following spring for corn. Raw ground phosphate rock and acid phosphate are applied separately to the individual plots in quantities varying from 300 to maximum of 1,500 pounds per acre. One-third of the fertilizer is applied to the corn and two-thirds to the wheat. Seven plots in each series being left without treatment, serve as checks with which to compare the treatments.

*Cooperation.*—Conducted by the Department of Agronomy until January, 1917.

*Location.*—Branchville, Maryland.

*Date begun.*—1914.

*Results.*—The results to date are summarized in the following table:

	Four year average yield per acre	
	WHEAT	CORN
Checks (average of 7 plots) .....	7.8	22.9
Acid Phosphate (average of 5 plots).....	22.5	41.7
Raw Rock Phosphate average of 11 plots) . . . . .	12.3	30.0
Gain for Acid Phosphate.....	14.7	18.8
Gain for Raw Rock Phosphate.....	4.5	7.1

The marked superiority of the acid phosphate is very evident from the above results. Attention is called to the fact that the land upon which work is being conducted was in a very low state of fertility and deficient in vegetable matter (average yield of unfertilized plots being 7.8 bushels of wheat and 22.9 bushels of corn) and that no manure has been used, a cover crop of crimson clover being used to supply organic matter.

*Persons engaged.*—N. Schmitz, W. E. Hanger, A. G. McCall and L. W. Erdman.

*Project 10.*—(Branchville Project 5.)—Lime requirements of an acid soil.

*Object.*—To compare the value of different forms of lime. Maryland offers a variety of lime-bearing materials, many of which are being used as the source of agricultural lime. In some sections of the state oyster shell lime is found in abundance, while in other sections the limestone rock furnishes an adequate supply of lime. Furthermore these materials are offered to the farmer in the raw pulverized form or in the burned form. It is important, therefore, that we have some definite information as to the relative value of these materials from different sources, both in the raw and in the burned form.



*Procedure.*—This project comprises two series of 15 plots each upon which wheat and corn are grown in alternate years, with crimson clover seeded after the wheat to be plowed down for corn the following spring. All applications of lime were made at the beginning of the experiment, and in amounts varying from 1,000 pounds to a maximum of 10,000 pounds per acre.

*Cooperation.*—Conducted by the Department of Agronomy until January 1, 1917.

*Location.*—Branchville, Md.

*Date begun.*—1914.

*Results.*—The results to date are summarized in the following table:

Treatments	Four year average yield	
	WHEAT Average of 3 plots	CORN Average of 3 plots
Average of all checks . . . . .	13.1	32.5
Raw Oyster Shell (pulverized) . . . . .	18.9	36.5
Raw Limestone (pulverized) . . . . .	17.4	38.8
Burned Oyster Shell . . . . .	20.4	40.3
Burned Limestone . . . . .	21.1	38.6
Gain for Raw Oyster Shell . . . . .	5.8	4.0
Gain for Raw Limestone . . . . .	4.3	6.3
Gain for Burned Oyster Shell . . . . .	7.3	7.8
Gain for Burned Limestone . . . . .	8.0	6.1

It will be noted that the raw oyster shell has given a slightly greater yield of wheat than the raw limestone, but for the corn the increase is in favor of the limestone. The burned limestone has given a larger yield of wheat but a smaller yield of corn. Except for slight difference in favor of the burned forms, there seems to be little room for choice between the materials except in the matter of cost.

*Persons engaged.*—N. Schmitz, W. E. Hanger, A. G. McCall and L. W. Erdman.

*Project 11.*—Soil management and fertilizer investigations.

*Object.*—To study problems of soil management and fertilizer treatments as applied to the upbuilding of the fertility of the more important soil types of the state.

*Procedure.*—Fields in different sections of the state have been leased and laid off into small plots upon which crops are being grown under definite rotations, both with and without manurial and fertilizer treatments. An accurate record is being kept of the treatments and the yields with a view of determining for each soil type the best and most profitable system of soil management. Since these fields are located on typical soils, the results are applicable to large areas of similar soils in the same and adjacent counties. Farmers meetings are held at these experimental fields for the purpose of giving farmers an opportunity to see the results of different cropping systems and fertilizer practices.

*Cooperation.*—County Agricultural Agents.

*Locations.*—Leonardtown, St. Mary's Co.; La Plata, Charles Co.; Princess Anne, Somerset Co.; Ridgely, Caroline Co.; Chestertown, Kent Co.; Perryman, Harford Co.; Crownsville, Anne Arundel Co.; Ellicott City, Howard Co.; and Frostburg, Garrett Co.

*Date begun.*—See separate projects.

*Results.*—The following is a brief description of the work at each substation, together with a summary of the results to date:

*Leonardtown.*—On Almshouse Farm.

Soil type.—Leonardtown silt loam.

Rotation.—Corn, wheat, clover, tobacco with cover crop of crimson clover or rye seeded in the tobacco at last cultivation. Number of plots, 205; size, one-fortieth acre.

*Work begun*—1916.

One section of this field has been tile drained and laid off in duplicate plots for comparison with plots not tile drained but which receive the same treatments.

The following summary of results brings out the wonderful response of this soil to applications of lime and manure and also the need for a complete fertilizer:

	Average yield per acre	
	WHEAT bushels	TOBACCO pounds
Acid Phosphate.....	12.2	299
Acid Phosphate and Lime.....	14.7	461
Nitrate and Phosphate.....	15.2	399
Nitrate and Phosphate and Lime.....	16.6	498
Nitrate, Phosphate and Muriate.....	17.3	380
Nitrate, Phosphate, Muriate and Lime.....	22.5	562
Manure and Acid Phosphate.....	12.8	458
Manure, Acid Phosphate and Lime.....	18.9	579
Manure and Raw Rock Phosphate.....	17.4	415
Manure, Raw Rock Phosphate and Lime.....	22.6	545

*Persons engaged.*—A. G. McCall, L. W. Erdman and John Wathen.

*La Plata*—On farm of J. R. Clark.

Soil type.—Leonardtown loam.

*Work begun.*—1919. Plans and outline of work not yet completed.

*Persons engaged.*—A. G. McCall, L. W. Erdman and J. R. Clark.

*Princess Anne.*—Princess Anne Academy Farm.

Soil type.—Elkton silt loam.

Rotation.—Corn wheat, clover, soy beans. Number of plots, 15; size of plots, one-twentieth acre.

*Work begun.*—1918 on the farm of Princess Anne Academy. No results to report.

*Persons engaged.*—A. G. McCall, L. W. Erdman and T. H. Kiah.

*Ridgely.*—Maryland Experiment Station Farm.

Soil type.—Sassafras loam.

Rotation.—Corn, wheat, clover, tomatoes, with a cover crop of crimson clover, or rye seeded at the last cultivation and plowed down for corn. Number of plots, 140. Size, one-twentieth acre.

*Work begun*—1916.

*Results.*—The following table summarizes the results for a few of the better treatments:

	Average yield per acre		
	CORN bushels	WHEAT bushels	TOMATOES pounds
Acid Phosphate .....	50.8	19.2	16600
Raw Rock Phosphate.. ..	47.7	20.6	15000
Acid Phosphate and Muriate.....	46.5	19.7	18300
Manure and Acid Phosphate.....	54.0	22.5	21600
Manure and Raw Rock .....	47.0	26.9	21700

*Persons engaged.*—A. G. McCall, L. W. Erdman, C. L. Opperman and A. White.

*Chestertown.*—On Almshouse Farm.

Soil type.—Sassafras loam.

Rotation.—Corn, wheat, clover, potatoes with crimson clover or rye seeded as a cover crop after the potatoes.

Number of plots, 36; size, one-tenth acre.

*Work begun.*—1917.

*Results.*—While this work has not been in progress a sufficient length of time to yield dependable results, the indications are that potassium is the limiting factor in the yield of potatoes. The two-year average yield of potatoes has been low, but both seasons show a marked response to muriate of potash treatment.

Treatment	Two-year average yield of potatoes bushels
Check—no treatment. ....	23.3
Acid Phosphate (1000 lbs. per acre) .....	23.2
Raw Rock Phosphate (1000 lbs. per acre).....	23.3
Acid Phosphate (600 lbs. per acre). ....	23.4
Raw Rock, 100 lbs., Muriate of Potash, 100 lbs.. .	44.4
Acid Phosphate, 600 lbs. and Muriate of Potash, 100 lbs. ....	46.2
Nitrate of Soda, 100 lbs. }	38.7
Acid Phosphate, 450 lbs. }	
Muriate of Potash, 50 lbs. }	

The effect of potash fertilizer on the wheat remains to be seen, since the wheat treatment is not such as to bring out the effect of potassium.

The wheat sections show a marked response to an application of 600 pounds per acre of a complete fertilizer and to manure reinforced with both acid phosphate and raw rock phosphate.

*Persons engaged.*—A. G. McCall, L. W. Erdman and F. Bayard Sutton.

*Perryman.*—On farm of Mr. Parker Mitchell.

Soil type.—Sassafras loam.

Rotation.—Continuous culture of sweet corn with cover crops supplemented by commercial fertilizers.

Number of plots, 28; size of plots, half-acre.

*Date begun.*—1918.

*Results.*—While the time that these plots have been under treatment is too short to draw any definite conclusions, the results indicate the need

for a complete fertilizer, but from the standpoint both of yield and earlier maturity. The corn in the plots receiving a complete fertilizer treatment has been ready to harvest a week in advance of the checks and those plots that are supplied with single elements or combinations of two elements of plant food material.

*Crownsville.*—On farm of State Hospital for the Insane.

Soil type.—Collington sandy loam.

Rotation.—Corn, wheat, clover, potatoes with crimson clover, rye or vetch seeded as a cover crop after the potatoes.

Number of plots, 36; size of plots, one-tenth acre.

*Results.*—A shortage of labor has made it impossible to conduct the work in a satisfactory manner; hence, no results can be reported at this time.

*Persons engaged.*—A. G. McCall, L. W. Erdman, Dr. Winterode, and Mr. Warfield.

*Ellicott City.*—On Doughregan Manor, the estate of Mr. Charles Carroll.

Soil type.—Chester loam.

Rotation.—Corn, soy beans, wheat and clover.

Number of plots, 84; size of plots, one-tenth acre.

*Date begun*—1917.

*Results.*—The treatments for these plots have been arranged with a view to determining the best place in the rotation to apply fertilizers and manures. Accordingly certain plots receive all fertilizer treatment on the wheat, others have the treatment applied to the clover, while still others have the treatments divided and applied at two places in the rotation. The results indicate a marked response of this soil to applications of manure and phosphorus, both in the form of acid phosphate and in the form of raw ground phosphate rock.

*Persons engaged.*—A. G. McCall, L. W. Erdman and Charles Haight.

*Frostburg.*—On the farm of Mr. Earl Michael.

Soil type.—Penn. shale loam.

Rotation.—Oats, clover, potatoes.

Number of plots, 104; size of plots, one-twentieth acre. The plots are in duplicate, one series being on old land and the other on recently cleared land.

*Date begun.*—1917.

*Results.*—In this rotation all fertilizers and manures are applied to the potatoes. The results from heavy applications of lime and the liberal use of stable manure on certain plots indicate that the use of these materials do not necessarily encourage the development of scab in potatoes, if care is taken to treat the seed. The following summary will indicate the effectiveness of different fertilizers upon the potato and the residual effect of the treatment upon the oat crop that followed the potatoes but which received no fertilizer:

Attention is called to the fact that the acid phosphate gave the highest yield of potatoes on the new land, while on the old land the yield was only 18 bushels above the check. The combination of manure and acid phosphate gave the best yield on the old land and next to the highest yield of potatoes on the new land. With respect to the residual effect, the largest yield of oats was secured from the plot that received 1,000 pounds of acid phosphate on the old land, while on the new land the plot receiving a complete fertilizer has given the largest yield of oats.

*Persons engaged.*—A. G. McCall, L. W. Erdman and Earl Michael.



Plot treatment	Yield in bushels per acre			
	Range 2 (new land)		Range 1 (old land)	
	Potatoes	Oats	Potatoes	Oats
Check, no treatment.....	197	47	156	36
Complete Fertilizer, 800 lbs.....	259	64	195	38
Nitrate of Soda and Acid Phosphate...	230	55	186	40
Manure and Acid Phosphate.....	263	48 ?	227	31
Raw Rock Phosphate, 2000 lbs.....	244	28	162	38
Acid Phosphate, 1000 lbs.....	271	60	174	47

*Project 12.*—The soil survey.

*Object.*—It is intended that the soil survey shall furnish a complete inventory of the soil resources of the state and that it shall serve as a secure foundation upon which the soil investigational work can be built.

*Procedure.*—Field parties make a study of the soils and indicate on a base map the extent and character of the soils which they encounter. Accompanying these maps are reports upon the general character and agricultural conditions of the county.

*Cooperation.*—Bureau of Soils, United States Department of Agriculture, and the Maryland Geological Survey.

*Location.*—See list of counties surveyed.

*Date begun.*—1900.

*Results.*—Previous to the inauguration of the present investigations thirteen counties had been surveyed and the reports published. Since 1916 the following counties have been completed:

Washington, 1917.

Carroll, 1918.

Baltimore, 1917.

Frederick, 1919.

Charles, 1918.

At the present rate it will require two more field seasons to complete the field work.

*Persons engaged.*—Carter, Smith, Burke, McCall, Latimer, Rose and Bruce.

*Miscellaneous Analyses.*—In addition to the regular routine analyses connected with the investigational work, the following service has been rendered since October, 1918:

*Persons engaged.*—A. M. Smith, L. W. Erdman and A. G. McCall.

Material Analyzed	Number of samples	Number of persons served
Soil (lime requirement)....	161	83
Limestone.....	17	13
Hen Manure.....	1	1
Muck.....	1	1
Water.....	1	1
Sulfur.....	1	1
Greensand.....	8	4

## FARM CROP INVESTIGATIONS.

## CORN PRODUCTION, SELECTION, BREEDING AND VARIETY ADAPTATION.

*Object.*—To determine the relative yields and adaptability of the principal varieties of corn offered for seed to Maryland growers, both for mature ear corn and for the silo; to find the proper rate of planting and to make a comparison of the methods in the selection of seed corn. The breeding work consists mainly of a study of methods of corn breeding and the testing of the progress made and the results attained by the seed corn breeders of the State.

*Procedure.*—The preparation of the land, the planting and the cultivation are the same as is practiced in approved methods of corn growing. A full record of the plant characters, seasonal requirements and productive power for each variety is kept. The seed is obtained annually from the growers. In 1920 duplicate plots will be planted from the 1919 seed supply in order to determine more fully the variations due to seasonal conditions. The same accurate records are secured at all sub-stations. Seed ears are secured annually from several corn breeders and tests are made to determine the possibility of further improvement of the strains of corn.

*Cooperation.*—Individual farmers.

*Location.*—College Park, Ellicott City, Ridgely, Indian Springs, La Plata.

*Date begun.*—1903 (at sub-stations, 1917 and 1918).

*Results.*—Forty-seven varieties have been tested since the project was begun. Of this number sixteen varieties and strains are in the tests at present. Among those giving the best yields are Boone County White, Johnson County White, Excelsior, Thomas and Funk's Yellow Dent. The varieties giving the highest yield of ensilage are Cocke's Prolific, Johnson County White, Boone County White, and Excelsior. Great variation is noted in the results obtained with the varieties due doubtless to the differences in the soil types and their fertility and the elevation on which the corn is grown. Two plants per hill have given larger yields of shelled corn but less stover than three plants per hill. The sub-project on testing the progress made by the commercial seed corn breeders was begun in 1919.

*Assignment.*—J. E. Metzger and Geary Eppley, Geo. R. Stuntz, Albert White and Charles F. Haight.

## TESTS OF VARIETIES OF COWPEAS FOR SEED AND HAY.

*Object.*—The object of this project is to determine the best varieties of cowpeas for use on Maryland farms for hay, green manure and for seed production.

*Procedure.*—The tests for seed are made on single row plots. A full record of plant characters is secured during the growing season and the yields noted. The hay varieties are grown on twentieth-acre plots. Observations on the varieties for green manure purposes are made prior to cutting the plots for hay.

*Location.*—College Park.

*Date begun.*—1909.

*Results.*—Thirty-eight varieties, including several which have been obtained through hybridization, are in the tests. The varieties which have given the best results are: Wonderful, Whippoorwill, Groit, New Era, Gray Crowder and Black. Sufficient data have been accumulated to warrant a publication of the results in full at an early date.

*Assignment.*—J. E. Metzger, Geary Eppley.

## EXPERIMENTS IN FORAGE, GREEN MANURE AND WINTER COVER CROPS.

*Object.*—The purpose of this experiment is to determine the best use of rye, winter vetch, sweet clover, the common clovers and alfalfa for forage, green manure and winter cover crop purposes.

*Procedure.*—The methods pursued in this project are the same as those that may be practiced under ordinary farm conditions. Fall and spring plantings are made with the common clovers, sweet clover and alfalfa. Rye and winter vetch are planted in the autumn. The studies with rye consist of the time of planting, rate of planting and yield of crop at time of plowing under. Harvesting dates are noted for winter vetch for both hay and seed production. The yield on the sweet clover is secured with reference to its value if turned under for a fall planted crop..

*Cooperation.*—Animal Husbandry Department.

*Location.*—College Park.

*Date begun.*—1918.

*Results.*—The results thus far would indicate that the value of rye for forage, winter cover and green manure depends almost entirely upon the date at which it is planted. Plantings made September 15th have yielded five times as much manurial material as plantings made November 15th. August plantings of alfalfa have been more successful than spring plantings.. Clovers as well as clover and grass mixtures have produced higher yields and better quality of hay than similar plantings with a cereal crop. Spring plantings of sweet clover when turned under in August have supplied the soil with a larger amount of nitrogen than is ordinarily contained in the high-grade fertilizer used for a cereal crop.

*Assignment.*—J. E. Metzger, Geary Eppley and Geo. R. Stuntz.

## METHODS OF HARVESTING TEST PLOTS.

*Object.*—The purpose of this project is to study the accuracy of records secured by harvesting a portion of a plot in comparison with the yields secured from the entire plot. Also to check the accuracy of field notes when taken on measured portions of the plot against those secured at random.

*Procedure.*—A frame exactly one five-thousandths of an acre is used to lay off the small plots. In the harvesting five of these areas are secured from uniformly fixed positions on the plots. Samples are weighed and the yield calculated on an acre basis. These yields are later compared with those secured from the entire area.

*Location.*—College Park.

*Date begun.*—1917.

*Results.*—To date results have been secured for both wheat and soy beans grown for hay. The method has also been used in securing yields of forage crops and green manure crops. From the figures obtained thus far it may be concluded that the method is accurate enough for experimental work. However, slightly higher yields are secured from the small plots than from the entire plots. Graphical representations of the yields secured by the two methods show uniform variation.

*Assignment.*—J. E. Metzger.

## SOY BEAN INVESTIGATIONS.

*Object.*—There are three phases to this project: viz., a study of the adaptation of imported varieties, selections for superior types of plants and tests of the yields for hay and seed of varieties that are suited to Maryland climate.

*Procedure.*—The seed used in these studies and tests are secured from other experiment stations, the United States Department of Agriculture and from commercial growers. New varieties and varieties under test for

seed production are planted in replicated single-row plots. The varieties planted for hay are planted in twentieth-acre plots.

*Cooperation*.—Individual farmers.

*Location*.—College Park, Ridgely, Ellicott City and farmers in each county of the State.

*Date begun*.—1910.

*Results*.—Thirty varieties have proven their adaptability to the seasonal conditions of Maryland and show sufficient yielding ability to warrant their use in this state. Of sixty newly-imported varieties which are being studied more than forty promise satisfaction. The most successful varieties as shown by the tests to date are Virginia, Wilson, Cloud, Ito San, Peking, Edna, Medium Yellow and Mammoth Yellow. Thus far the selection work has not given any marked results.

*Assignment*.—J. E. Metzger, Geary Epply, Albert White.

### SUGAR CORN SEED PRODUCTION AND BREEDING.

*Object*.—To compare the yields of sugar corn grown for both seed and canning purposes from Maryland and northern-grown seed and to breed desirable types of corn for canneries.

*Procedure*.—Sugar corn seed is secured from a reliable northern grower and from local canners who produce their own seed. Two varieties are used in the studies. The plots consist of four rows and are duplicated. Every alternate row has the succors removed. Half the plot is harvested at the canning stage and the other half is allowed to mature seed. Records are kept for both merchantable and unmerchantable yields.

*Cooperation*.—Commercial canners.

*Location*.—College Park, Ridgely.

*Date begun*.—1915.

*Results*.—Native-grown seed produces a larger plant and during each year of the experiment has given higher yields than northern-grown seed. The chief difficulty in growing native seed seems to be the ravages of the corn ear worm and the crossing with common field corn. There is no evidence that a variety or strain deteriorates under Maryland conditions when the proper precautions are used in handling the crop. The removal of the succors has had no material effect on the yields secured. The breeding work was begun in 1918.

*Assignment*.—J. E. Metzger, Geary Epply, Albert White.

### STUDIES IN CROP ROTATIONS.

*Object*.—It is the purpose in this study to determine the most profitable point in the rotation to apply the usual fertility measures practiced by Maryland farmers and to measure the effect of the manure and fertilizer used on the yields secured in the succeeding crops. The experiment supplements the project reported in Bulletin 202.

*Procedure*.—Two grades, representing the most usual analyses of fertilizers used on farms on which corn, wheat and hay are the major crops, are used in this experiment. Manure is applied at two different rates, each of which is supplemented with sufficient commercial fertilizer to bring the total plant food to a uniform basis. Each plot receiving treatment is bordered by a no-treatment plot. Treated plots receive only one application during the rotation.

*Location*.—College Park.

*Date begun*.—1919 (August).

*Assignment*.—J. E. Metzger, Geary Epply.



## TOBACCO SEED PRODUCTION.

*Object.*—The purpose of this work is to produce seed of the variety known as Maryland Mammoth and to find if possible a method by which this seed may be grown under ordinary farm conditions.

*Procedure.*—Roots with well-developed crowns are secured from the Upper Marlboro tobacco plots at the time of harvesting and transplanted in the greenhouse at College Park. The work thus far in attempting to secure seed from plants grown in the field have been along the lines of measures which dwarf and hasten.

*Cooperation.*—Upper Marlboro sub-station.

*Location.*—College Park.

*Date begun.*—

*Results.*—Each year from one to two pounds of seed is produced by this method. This seed is distributed among Maryland growers for demonstration purposes. The variety seldom fails to produce a very large increased yield over that of the common varieties of tobacco grown in this state.

*Assignment.*—J. E. Metzger, Edward Brown.

## VARIETY TESTS AND SELECTIONS OF HARDY STRAINS OF WINTER OATS.

*Object.*—The object of this experiment is to secure strains of several of the leading varieties of winter oats which will be sufficiently hardy to withstand the winters of northeastern as well as southern Maryland and to test the yielding ability of the strains selected.

*Procedure.*—The details of the cultural methods employed are the same as for all fall planted cereals, except that the oats is planted from ten days to two weeks earlier than the best date for planting wheat. The selection work has been with reference to plants which endure the winters well and the leaf area of the plant. A large number of plants are labeled at the time when the leaves have made their maximum growth. The leaf product is determined for one culm of each plant selected. The selections are determined by the results of these measurements.

*Location.*—College Park and La Plata.

*Date begun.*—1908. (Selections in 1918.)

*Results.*—This work has been interrupted several times by severe winter conditions, the last of which occurred in 1916 and 1917. The varieties which have given best results are Culberson, Bicknell and three lots of the Winter Turf group. The highest single yield secured was sixty-four bushels per acre. This was made by Bicknell. Thus far the selections have been made in Culberson only. The selection work has not progressed far enough to report definite results.

*Assignment.*—J. E. Metzger, Geo. R. Stuntz.

## WHEAT VARIETY TESTS AND IMPROVEMENTS BY SELECTION AND BREEDING.

*Object.*—The aim of this work is to test the yielding qualities of all of the varieties and strains of winter wheat which may be adapted to Maryland conditions, the improvement of the best varieties by selections and tests of individual heads and the creating of new wheats by hybridization.

*Procedure.*—As far as possible samples of all new varieties of wheat reported are secured and placed in test. The plots vary in size from five-foot rows to a twentieth of an acre and larger areas for multiplication purposes. The records secured include notes on the yield, quality, classification, adaptability and disease resistance. The head selections are made from the station plots and on individual farms. A large number of crosses are made each year and the progeny tested for the desired quality.

*Cooperation.*—Sub-stations and individual farmers.

*Location.*—College Park, Ellicott City, Ridgely, and cooperators in all of the counties of the state.

*Date begun.*—1890.

*Results.*—Forty-eight varieties and strains are in the tests at the present time. Bearded Purple Straw, Dietz Longberry, Mammoth Red, Currell's Prolific and China have been the five leading varieties during the past twelve years. During this time they have changed places in their ranking, but none of them have dropped below fifth place in any year. Of the one hundred and fifty varieties that have been tested to date mention should also be made of Fulcaster, Gold Coin, Rudy and Leap's Prolific. None of the highly advertised new varieties have proven themselves of any special merit. Approximately three thousand selections of heads of wheat are made annually and are tested by the Head-to-Row Method. The results of this work have been very gratifying. Several varieties which were inclined to produce weak culms have by this method been improved so that the present strains produce straw of sufficient rigidity to prevent their lodging under normal conditions. Other aims in the selections are compactness of head, stooling qualities and disease resistance. A number of very promising hybrids are being developed at the present time. Practically all of the wheat grown on the Experiment Station Farm during the past ten years has been distributed among the farmers of the state, with the result that a large percentage of the wheat grown in Maryland is of the varieties which have done best at the Experiment Station.

*Assignment.*—J. E. Metzger, J. B. Wentz, Geary Epply, Geo. R. Stuntz, Albert White, Charles Haight.

## POMOLOGICAL INVESTIGATIONS.

### PROJECT NO. I.: GRAPE TRELLIS AND TRAINING EXPERIMENTS.

*Object.*—To determine which system of pruning is most profitable in the case of the grape. The systems used and varieties follow:

Six systems:

Kniffin 1	Umbrella 2
Kniffin 2	Fan
Umbrella 1	Munson

On eight varieties:

Moore Early	Diamond
Campbell	Wyoming
Concord	Niagara
Lutie	Worden

*Procedure*—Three vines of each variety were pruned in each above six systems. Records of bloom, number of bunches, and yield per vine were recorded.

*Location.*—Experiment Station, College Park, Md.

*Date begun.*—1914.

*Results.*—The records show that either system of pruning seems satisfactory if properly carried out. Results are soon to be published in bulletin form.

*Assignment.*—W. R. Ballard.

### PROJECT NO. II.: TEST OF VINIFERA GRAPES UNDER MARYLAND CONDITIONS.

*Object.*—To determine whether this desirable type of grape can be grown under our conditions by using certain methods of culture, etc.

*Procedure.*—Two vines each of hardest varieties grafted on phylloxera resistant roots; vines to be thoroughly sprayed to control fungus enemies; canes laid down and covered with earth as winter protection.

Varieties:

Chas. Rose Royale	Frankenthaler
Chas. Rouge	Flame Tokay
Lignan Blanc	Damascus
Mission	Muscat Albardien
Burger	Jura Muscat
Rozaki	Malaga
M. Noir Precoce	Chas. Dore
Zinfandel	

Vinifera hybrids also included:

Downing	Barry
Croton	Corby Seedling
Salem	Montclair
Wilder	Iona
Massasoit	Diana
Merrimac	Dutchess

Grafter vines difficult to get; cutting grafts made, scions coming from California through courtesy of Geo. Hushman, United States Department of Agriculture, arrived in poor shape, small percentage grafts grew. Notes on vigor of growth, yield of fruit, etc.

*Location.*—College Park, Md.

*Date begun.*—1914.

*Results.*—Practically no fruit produced thus far. Some vines died outright, others made little growth, a few vigorous.

*Assignment.*—W. R. Ballard.

#### PROJECT NO. III.: GRAFTING DELAWARE GRAPE ON VARIOUS STOCKS.

*Object.*—To determine value of stocks in producing more vigorous growth in this rather weak grower.

*Procedure.*—Delaware grafted on following stocks:

Riparia x Rupestris 3306	Rupestris St. Geo.
Riparia x Rupestris 3309	Clinton
Riparia glabre	

Measurements made of total annual growth; number and weight of bunches of fruit.

*Location.*—Experiment Station, College Park, Md.

*Date begun.*—1914.

*Results.*—Difficult to secure material. Only few vines secured for setting in vineyard. Growth of canes for 1918 in table (see 1918 Ann. Report). Best growth so far on Clinton stocks. Number and weight of fruit bunches for 1919 secured.

*Assignment.*—W. R. Ballard.

#### PROJECT IV.: GRAPE BREEDING.

*Object.*—First to determine crosses giving best promise in progeny, following species to be used:

Vinifera for quality.

Labrusca for vigorous vines and general adaptability.

Riparia for hardiness.

Aestivalis for disease resistance.

Second to utilize best breeders in production of better varieties for humid sections of Maryland. Incidentally to study breeding methods, pollination laws.

*Procedure.*—Collection of varieties secured. Crosses made combining various parents; seedlings raised, planted in vineyard at distance of 2-3 ft. in row. Grown to single cane and brought into fruit as soon as possible. Notes and descriptions made as seedlings fruit.

*Location.*—College Park, Md.

*Date begun.*—1912.

*Results.*—Number of crosses made; approximate number seedlings secured, 800; approximate fruiting, 450. Promising parents: Iona, Winchell, Diamond. Most promising crosses: Winchell x Worden, Diamond x Clinton.

*Assignment.*—W. R. Ballard.

#### PROJECT NO. V.: TESTING NEW VARIETY STRAWBERRIES.

*Object.*—Determine value of new sorts.

*Procedure.*—Twenty-five plants of one hundred or more varieties grown in test plots. Each variety tested for at least three years. Fruit picked and weighed and accurate record kept of yield, also blooming and fruiting periods, disease resistance, stand; and full description made of plant and fruit. Several standard varieties grown for comparison.

*Location.*—College Park and Ridgely Farm.

*Date begun.*—1906.

*Results.*—More than 500 varieties tested and results published in bulletins 124, 160, and 211.

*Assignment.*—W. R. Ballard.

#### PROJECT VI.: VARIETY TEST OF BUSH FRUIT.

*Object.*—To determine varieties best adapted to conditions. Both new and old varieties of currants, gooseberries, raspberries, and blackberries grown.

*Procedure.*—Twenty-five to fifty-foot row grown and accurate record of winter injury, disease resistance, yield, etc., kept.

*Location.*—Experiment Station, College Park, Md.

*Date begun.*—1912.

*Results.*—Results tabulated and published in bulletin 182. Small fruits, yields secured from new plantings just becoming established.

*Assignment.*—W. R. Ballard.

#### PROJECT VII.: TEST QUINCE VARIETIES.

*Object.*—To determine adaptability of varieties and reasons for difference of culture.

*Procedure.*—Two bushes of six varieties planted. Observations made as to disease and insects.

*Location.*—Experiment Station, College Park, Md.

*Date begun.*—1912.

*Results.*—Fire blight determined to be greatest single factor in failure of plants to live and thrive; preliminary observations indicate tarnished plant bug largely responsible for twig infections. Little fruit secured thus far. Variety Orange most resistant to troubles.

*Assignment.*—E. C. Auchter and W. R. Ballard.

#### PROJECT VIII.: PRODUCING APPLE STOCKS BY CUTTINGS.

*Object.*—To produce uniform stocks for apple, particularly desirable for experimental work.

*Procedure.*—Little success resulting from various methods of treating cuttings of ordinary varieties; idea of breeding vigorous stock which could



be rooted from cuttings suggested itself. Crosses made using Doucin as male parent and Gravenstem as female.

*Location*.—Experiment Station, College Park, Md.

*Date begun*.—1915.

*Results*.—Material limited and only few crosses could be made; 250 buds Gravenstem x Doucin, 50 fruit, 100 seeds. Only 2-3 seedlings secured; not particularly vigorous.

*Assignment*.—W. R. Ballard.

#### PROJECT IX.: VARIETY TEST APPLES.

*Object*.—Determine adaptability to Maryland conditions.

*Procedure*.—Both old and new sorts planted in orchards. Study made of tree and fruit, blooming and fruiting periods, use, etc.

*Location*.—Experiment Station, College Park, Md.

*Date begun*.—1888. (1899, 1902, 1903, 1907, 1914 other orchards.)

*Results*.—Notes taken on disease resistance, blooming period; descriptions of varieties made. Results published in bulletins 144 and 178 and various reports State Hort. Soc., etc. Approximately 350 varieties in test.

*Assignment*.—E. C. Auchter and W. R. Ballard.

#### PROJECT X.: APPLE BREEDING.

*Object*.—Primarily origination of good variety of early apples with good red color and shipping qualities.

*Procedure*.—Crosses between best commercial types of early apples made; seed planted and seedlings grown and fruited. Promising types to be propagated, given thorough test and distributed.

*Location*.—Experiment Station, College Park, Md.

*Date begun*.—1906.

*Results*.—Approximately 1,500 seedlings growing. About 250 fruited, 15 promising enough to propagate. Preliminary reports (includes pear breeding) in bulletin 196, Methods and Problems in Pear and Apple Breeding. Incidentally valuable information secured on question of ability of varieties as pollinizers.

*Assignment*.—E. C. Auchter and W. R. Ballard.

#### PROJECT XI.: PEAR BREEDING.

*Object*.—To secure varieties of quality resistant to blight.

*Procedure*.—Kieffer as one of the most resistant to blight largely used as basis for crosses with other better quality varieties, notably Seckel, Duchess, Anjou, etc. Methods similar to those used in apple breeding.

*Location*.—Experiment Station, College Park Md.

*Date begun*.—1905.

*Results*.—Approximately 600 seedlings growing, 100 fruited, a few promising, but good quality not fully determined as yet. Preliminary report bulletin 196.

*Assignment*.—E. C. Auchter and W. R. Ballard.

#### PROJECT XII.: GERANIUM VARIETIES.

*Object*.—Test geranium varieties in relation to their adaptability to Maryland; to breed types better adapted to use as bedders.

*Procedure*.—Over 100 varieties planted in garden. Notes taken on disease resistance, habit of growth, etc. Crosses made in greenhouse between best types, and seedlings raised and flowered.

*Location*.—Experiment Station, College Park, Md.

*Date*.—1907.

*Results.*—Approximately 500 seedlings raised. Results published in 1918, Report of S. H. S. A few seedlings of value for conservatory but none superior to bedding types now in use.

*Assignment.*—W. R. Ballard.

#### PROJECT XIII.: METHODS OF GROWING STRAWBERRIES.

*Object.*—To determine if better methods of producing crop in strawberry regions could not be found.

*Procedure.*—Five plots laid off and treated as follows:

1. Local fertilizer practice (includes spring application nitrate of soda).
2. Limed.
3. Check.
4. Mulched.
5. Fertilized during growing season with mixture: 180 lbs. tankage, 45 lbs. nitrate soda, 210 lbs. acid rock, 175 lbs. potash; applied rate 1,500 lbs. per acre, three applications.

Variety Superior used in test. Three-year rotation with truck crops. Variety test also included.

*Location.*—Ridgely, Md.

*Date begun.*—1915.

*Results.*—Soil plots turned out to lack uniformity. Fertilizer mixture changed on account war conditions. Record of yields as follows:

Plot	1	2	3	4	5
1916	454.1	377.6	360.5	348.0	342.8
1917	364.5	422.5	416.0	541.5	561.5
1918	495.0	249.5	290.0	394.0	575.0
Aver.	437.8	349.8	355.5	427.8	493.1

*Assignment.*—E. C. Auchter and W. R. Ballard.

#### PROJECT XIV.: DEVELOPMENT OF FRUIT IN PERSIMMON AND PAPAW.

*Object.*—To test deductions made by previous workers and to study histology, morphology, and physiology of these fruits.

*Procedure.*—Buds collected at different stages, growth, killed, embedded, and slides made.

*Location.*—Experiment Station, College Park, Md.

*Date.*—1916.

*Results.*—Material collected, a few slides made, but work interrupted by war period.

*Assignment.*—W. R. Ballard.

## PROJECT XV.: NUT CULTURE.

*Object.*—To test the adaptability of varieties to Maryland conditions; to investigate methods of propagation, culture, pollination, etc.

*Procedure.*—All of the varieties of pecans and Persian walnuts on the market which give promise of success are being grown on the Experiment Station grounds. In addition, several hundred trees of leading varieties were distributed to interested parties in many sections of the state, and ten test orchards planted in representative sections. Several varieties of Black Walnut, Japanese Walnut, and miscellaneous nut trees have been added to the collections.

*Co-operation.*—Carried on at Experiment Station grounds with several growers on farms in different parts of the state cooperating.

*Location.*—Experiment Station, College Park, Md., nut orchards at Oakland, Hancock, Loveville, Galena, Havre de Grace, Berlin, Thurmont.

*Date begun.*—1907.

*Results.*—A nut survey made of the state and published in Bulletin 125, February, 1908. Report on trees planted in Bulletin 218, June, 1918. Most of the southern varieties of pecans not hardy enough for conditions. Hardy types found more satisfactory. Persian walnuts suffer from blight, winter injury, and bud worm. Indications that the greatest promise for the future lies with the native black walnuts and the Japanese walnuts.

*Assignment.*—E. C. Auchter.

## PROJECT XVI.: PEACH, PLUM AND CHERRY CULTURE.

*Object.*—To test adaptability of varieties to Maryland conditions. To investigate methods of culture and fertilization, etc.

*Procedure.*—Many of the leading varieties of these fruits have been planted in the Experiment Station orchards. Observations made on blooming and fruiting periods, disease resistance, hardiness, productiveness, etc.

*Location.*—College Park, Md.

*Date begun.*—1888.

*Results.*—Bulletins 159, Peach Culture, October, 1911; 207, Plum Growing in Maryland, May, 1917, give results of work with peaches and plums. Data collected on cherry but not published.

*Assignment.*—E. C. Auchter.

## VEGETABLE INVESTIGATIONS.

*Subject.*—Variety testing of novelties, or apparently worthy kinds of the most important vegetables.

*Object.*—Discovery of new kinds that are better adapted to the special conditions of the different soils and climate in the several sections of the state. Some vegetables when grown under conditions that are debilitating to the plant and favorable to the production of disease germs become so weakened as to be no longer profitable. Many new varieties are strong and vigorous and can be selected to replace the debilitated stock. Producers of new varieties among the farmers of the state wish to have their productions tried alongside some of the standard kinds.

*Procedure.*—Samples of seed of new varieties are secured of the prominent seedsmen. They are planted on blocks of ground that are of uniform fertility, and records of the yield and notes on general characters, disease resistance, etc., are kept. Some of the standard sorts are always planted with them for comparison. If there is any bad outbreak of disease, special effort is put on discovering something that will withstand it. For instance, when the melon blight became very bad, inquiry was made and a lot of varieties were secured from localities where the climatic conditions were

such that melons would grow with the greatest difficulty. The coming season, on account of the severe damage to the garden pea crop on the Eastern Shore, it will be well to secure a lot of different stocks of the Alaska pea, hoping to find some that are disease resistant when planted on infected soil.

*Cooperation.*—Varieties of potatoes, peas, beans, ruta bagas, cabbage, cauliflower, brussels sprouts, onions, and lettuce are being tried on the farm of the Weber Bros., Oakland, Md. Irish potatoes on the farm of Mr. Alex. Gude, Hyattsville, Md. Potatoes and tomatoes are on test at the Ridgely Station.

*Date begun.*—This is a continued project and considered as routine work.

*Location.*—College Park, Oakland, Hyattsville and Ridgely.

*Results.*—Some valuable data has been secured so that, upon inquiry by growers, information can be given as to the adaptability of a variety to their special conditions. Also, it enables a checking up of seedsmen who put an old variety on the market under a new name. This practice is quite common and results in taking thousands of dollars annually from the growers in an unfair way. Some disease-resistant varieties have been discovered of cabbage, celery, lettuce, melons. The best varieties of potatoes for late planting have also been found and recorded.

*Assignment.*—Thos. H. White, Albert White.

*Subject.*—The suitability of Garrett County for the production of cool-climate vegetables during the summer.

*Object.*—To make some tests to ascertain if the climate of the neighborhood of Oakland, at which the air temperature averages eight to ten degrees lower than the lower part of the state, is sufficiently cool to produce the vegetables that are ordinarily produced further south during the late spring months.

*Procedure.*—An acre of land is planted. Varieties of lettuce, cabbage, peas, ruta бага, cauliflower, onions, brussels sprouts are used. Notes on the growth and yield are kept.

*Cooperation.*—Weber Bros., County Agent of Garrett County.

*Location.*—Oakland, Md.

*Date begun.*—1917.

*Results.*—The work has not proceeded as well as could be wished, but it is sufficient to show that all the vegetables named can be successfully grown. Ruta bagas, sown as early as the ground can be worked, make a heavy crop. Cabbage of the Danish Ball-head type, that do not do well in the southern counties, grow well. Worms that eat the leaves, and cause much destruction in the Eastern parts of the state, rarely ever do any damage to the cabbage crop. Cauliflower grows exceedingly well and is profitable. The large wrinkled type of garden pea, such as Telephone or Gradus, when planted about the last of June, produces an excellent crop the last of August and early September. Lettuce to mature in August can also be successfully grown. Brussels sprouts will grow and mature if planted early. Celery and onions also do well. There is a good opportunity for the operation of a pea cannery, to pack the large wrinkled types of peas. These types are not profitable from the packers' standpoint in the lower parts of the state.

*Assignment.*—Thos. H. White.

*Subject.*—Plant food requirements of asparagus.

*Object.*—The proper fertilizing of asparagus. To find the proper amounts of fertilizers or a combination of both and the best time of application to the asparagus bed.

*Procedure.*—Four plots containing one-tenth acre were arranged on a bed of asparagus that had been planted seven years and had not received in that time manure or fertilizer. These plots receive stable manure at the rate of ten tons per acre and fertilizer at the rate in money value as



the manure. These are applied in the spring, and directly after cutting. There are also a series of clay cylinders set in the ground and filled with bank sand. These will be used to the effect of different amounts of nitrogen, phosphoric acid and potash with and without manure.

*Location*.—College Park.

*Date begun*.—1917.

*Results*.—Larger yields have been noted from the plots receiving the commercial fertilizer, and this is greater when the fertilizer has been applied in the early spring. The cylinders have not yet been treated with the different materials, but have been given sufficient fertilizers to insure normal growth.

*Assignment*.—Thos. H. White.

*Subject*.—Various projects being conducted in the greenhouse.

*Object*.—To assist greenhouse men in solving some of the problems in their line of work.

- (a) How to get seed on the ten-week stock (*Mathiola icana annua*) to produce a large per cent. of double flowers.
- (b) A study of some of the causes of the bursting of the carnation calyx, with special reference to its inherited character.
- (c) Testing the difference between seed of the Spencer type of winter flowering sweet pea grown in the greenhouse and outdoors in California.
- (d) Fertilizer treatments of tomatoes with especial reference to the production of dwarfier plants, with short internodes, during the warm part of the fall months.

*Procedure*.—

(a) Cramping the roots in pots. Saving seed from pods on different parts of seed stalk. Following out progeny of certain individuals.

(b) Beacon has been planted and cuttings will be taken from individuals showing inherited tendency to burst the calyx.

(c) Standard varieties are being grown and seed saved from them. After a few generations grown in this way some seed of the same varieties will be secured from California.

(d) Applications of acid phosphate, nitrate of soda, kainit will be made, separate and in combination. The effect on the strength of the growth of the tomatoes will be noted.

*Location*.—College Park.

*Date begun*.—(a) 1915; (b) 1919; (c) 1915; (d) 1919.

*Results*.—Starving the plants of the stock by cramping the roots in pots did not result in any greater amount of double blooms. So far, without having made any comparative tests, the greenhouse-grown sweet pea seed does well.

*Assignment*.—Thos. H. White.

*Subject*.—Soil fertility studies from the standpoint of the vegetable grower.

*Object*.—To assist vegetable growers in the economical use of manure and fertilizers. Animal manures are becoming scarce, and it will be necessary to supplement, wherever possible, with chemicals and green manures.

*Procedure*.—Three series of four plots, one-tenth acre in size, on a light clay loam soil are being fertilized with stable manure alone, commercial fertilizers alone, and a combination of manure and fertilizer, half quantity of each. Four tons, eight tons, and twelve tons of stable manure is applied per acre in one series. Fertilizers approximating in value to the stable manure and as may be best suited to the crop to be grown are applied to the second series. And to the third series, half of the amounts of the stable manure and fertilizers are applied to each plot. A check plot to which no manure or fertilizers are applied is in each series. Vegetable crops, such as cabbage, potatoes, garden peas, corn and spinach, are planted and a record of the yields is kept.

Another series at Ridgely Station contains four half-acre plots. These are treated in duplicate. Vegetable crops are grown and on one set fertilizers at the rate of \$10 dollars worth per acre are used alone, and on the other the same amount in money value of stable manure alone, green crops like crimson clover, are used in the rotation as a catch crop.

A third series of plots is arranged, at College Park, in duplicate on a very poor piece of loam soil to test the advantage of heavy applications of the limestone and phosphate rocks on the physical condition of the soil, with especial relation to its water-holding capacity. Five plots containing one-fiftieth acre each are treated at the rate of four tons per acre with acid phosphate, land plaster, ground limestone, ground oyster shells, and ten tons of stable manure respectively. There is also a check plot which receives no fertilizer. All kinds of vegetable crops will be planted and growth and weight, etc., noted. Fertilizers to supply the nitrogen, phosphoric acid and potash are also used.

*Location.*—College Park Station and Ridgely Station.

*Date begun.*—Spring of 1915. July, 1919.

*Results.*—Six crops have been grown on the first series mentioned. They were potatoes, cabbage, garden peas, and sugar corn. The fertilizers and manure have all greatly increased the yield. The increase is slightly the greater on the plots receiving manure. Those receiving fertilizer alone are nearly as good as those receiving manure alone and slightly better than the plots receiving the combination.

With regard to the series at the Ridgely Station, the yields have been generally one-third larger in favor of the manure. The crops planted were canteloupes, potatoes, tomatoes, sugar corn, and garden peas.

The third series is planted with late potatoes and are not yet mature.

*Assignment.*—Thos. H. White, Albert White.

*Subject.*—Conserving the plant food in trucking soils during the winter.

*Object.*—To determine what is the best to do with a piece of land that has had a crop to mature on it too late to plant any other truck crop, and will be needed in the spring for an early crop, like potatoes.

*Procedure.*—Three plots containing one-tenth acre each were arranged on a level piece of light clay loam soil of a fairly fertile character. Rye is sown on one, one is left in the same condition as when the previous crop was harvested, and one is ridged by throwing two large plow furrows together. As green rye turned down is claimed to be excellent for early potatoes, the plots are planted to this crop, each year. Irish Cobbler was the variety used.

*Date begun.*—Fall of 1916.

*Location.*—College Park.

*Results.*—Season of 1917 the best yield was on the plot that was ridged and the poorest on the plot that was left untouched from the previous crop. For the season of 1918 the best plot was the one left untouched from previous crop and the poorest on the ridged plot. For the season 1919 the yield was the best on the plot which had rye turned down and poorest on the ridged plot. The season of 1919 the potatoes grew more rapidly and made a better vine growth on the rye plot. It rained for several days in succession in early May, just as the potatoes were pushing through the ground. For the reason that there was a good growth of rye turned under the soil did not become as compact on this plot as it did on the others. As potatoes grow better when they get the right amount of air as well as moisture, the fact that the rye kept the soil more porous may have caused the better growth and yield.

*Assignment.*—Thos. H. White.

*Subject.*—An inquiry into some of the soil, fertilizer, and crop rotation conditions that may induce or aggravate the wilt disease of the garden pea.

*Object.*—To discover if possible some crop rotation or soil treatment that will help to obviate the effect of the wilt fungus on the pea crop of the Eastern Shore.

*Procedure.*—Plots have been arranged at the Ridgely Station so that there will be a rotation of the crops with the garden pea, with and without other legumes in the rotation. It has been noticed that when peas followed peas the effect of the disease has been very much worse. Another series of plots have been arranged to be started next spring using different amounts of lime and fertilizers on soil that was planted to peas that were badly infected.

*Cooperation.*—Saulsbury Bros., Ridgely, Md.

*Location.*—Ridgely Station and near-by land of the Saulsbury Bros.

*Date begun.*—July, 1919.

*Results.*—None to report at present.

*Assignment.*—Thos. H. White, Albert White.

*Subject.*—Variation of plants by growing them for successive generations in soil treated with large amounts of plant food.

*Object.*—A study of that part of the environment supplied by the soil and fertilizers on the changes of the cell structure in plants. It is well known that heavy applications of nitrogen, phosphoric acid and potash make temporary changes in the growth and vigor of plants, also in the size of fruit. If this could be made to become hereditary, it would be very helpful in the production of new varieties.

*Procedure.*—Seeds of peas, lettuce, radish, and tomatoes are sown in pots of soil that have been supplied with the different fertilizers. These are grown to maturity and the seeds again sown in the same soil treatment. Composite samples of seed are sown, so that a measure is taken of the plants as a whole, rather than individual variations. Samples of the seeds are taken from time to time and are planted under ordinary conditions. These are closely observed and notes taken of any variations that may be seen.

*Location.*—College Park.

*Date begun.*—December, 1907.

*Results.*—The most striking variation was that of the cherry tomato on the soil treated with large amounts of dried blood. This variation is published in Bulletin 173 of this station. The effect of the dried blood has been the most noticeable of the treatments. Lettuce showed fasciation of the stem and a dark-green stemmed sweet pea has been isolated. It may be said, however, that in the twelve years the plants have been under treatment they have not changed on the whole. The work as a whole shows that vigorous seeds and plants come from parents that are grown under the conditions of fertilizers that promote a vigorous plant growth.

*Assignment.*—Thos. H. White.

*Subject.*—The production of more suitable kinds of some of the more important vegetables, by crossing and selection. Also acclimatization and adaptability by growing the plants to the seeding stage under local conditions.

*Object.*—Some of the objects of this project are to produce tomatoes of better shape and more solidity for canning purposes. To produce varieties that under bad weather will make a good crop. Also some that are vigorous and free from blight and other diseases. Also celery, peas, and cabbage that are better adapted to the extreme heat of summer.

*Procedure.*—Varieties possessing the characters that are desirable to combine are brought together, usually in the greenhouse, and the pollen is transferred from one to the other. The plant thus crossed is carefully looked after until fruit and seed is secured. The seedlings are then

carefully grown and any of the progeny showing the desirable characters are saved for further growing and selection. For those subjects that are under the part of acclimatization and adaptability, the plants are grown until seed is produced. This is saved and again planted for several generations.

*Location.*—College Park.

*Date begun.*—1906.

*Results.*—As a result of the tomato crossing some very good varieties have been produced. This has been more along the line of size and solidity. The attempt to produce, by crossing a large pear type with the flattish round type, a longer fruit with a raised stem rather than one with the stem set in a deep cavity, has resulted in a fruit of that character but is not large enough to suit the canning trade. With regard to the plants grown with the purpose of their adaptation to the climatic conditions, it does not appear that much headway has been made. If a plant is selected that seems to be better suited to the conditions, it is usually a variant and different from the variety from which it is selected. Two varieties of late cabbage have been selected and bred closely so that if these can be grown under isolated conditions they may be kept pure. A lot of potatoes from the seed of the White McCormick, which is a variety that is well adapted to southern county conditions for late planting, are being grown this season. There is some evidence to show that some of these will be acquisitions, well suited to local conditions.

*Assignment.*—Thos. H. White.

*Subject.*—Suitability of some of the islands or points on the Bay or the Ocean for the production of cabbage seed.

*Object.*—Production in large enough quantity to be useful to large cabbage growers of improved strains and selections of cabbage. Cabbage seed of one variety grown on an island would not be as likely to become vitiated by crossing as when grown in adjacent blocks or fields as they are on Long Island. The modified air of the salt water is considered especially conducive to good growth in cabbage.

*Procedure.*—One strain or variety will be set in the fall in one locality. This will produce seed the following spring.

*Cooperation.*—Mr. James H. Hall, Point Lookout, E. I. Oswald, Worcester County, and others as they can be secured.

*Date begun.*—1919.

*Location.*—Point Lookout, Chincoteague Island.

*Assignment.*—Thos. H. White.

## TOBACCO INVESTIGATIONS.

### PROJECT: MARYLAND EXPORT TOBACCO INVESTIGATIONS.

*Object.*—To improve the crop by the development of better varieties and strains through breeding and selection; to determine the best use of fertilizers for tobacco; to ascertain the best systems of crop rotation adapted to tobacco culture; to investigate and to improve methods of growing, curing and handling tobacco, including the investigation and control of important diseases.

*Procedure.*—Pure and improved strains of the standard native varieties are obtained through systematic selection and testing and new types are produced by crossing the native with related foreign varieties, such as Connecticut Broadleaf and White Burley, followed by careful selection. Plat tests are carried out to ascertain the action of various fertilizing elements or materials on tobacco and the proper kinds and quantities of



fertilizer for best results with tobacco. Plat tests also are carried out to determine the merits of various cropping systems adapted for use on tobacco lands. The necessary technical studies of the tobacco and the soils used in the tests are made in connection with these investigations.

*Cooperation.*—Bureau of Plant Industry, U. S. Department of Agriculture.

*Location.*—Upper Marlboro, Md.

*Date begun.*—1905.

*Results.*—The Maryland Mammoth tobacco which has been developed has proven to be a very valuable type, especially in that growing this type under proper conditions makes it possible to secure high quality of leaf combined with large yields, which cannot be done with the ordinary varieties. A bulletin has been issued describing this and other new types which have given good results in the investigations. A bulletin also has been issued giving full details regarding the kinds and quantities of fertilizers which have given best results with tobacco in the tests extending over a number of years. Data have been secured on the comparative merits of several soil-improving crops for use on the tobacco soils. A study is being made of the root diseases of tobacco which are causing considerable losses to growers.

*Assignment.*—D. E. Brown and James Johnson.

#### PROJECT: PLANT NUTRITION INVESTIGATIONS.

*Object.*—To study crop relations, including the comparative effects of tobacco, potatoes, corn, wheat, oats, rye, grasses and legumes on the yields of succeeding crops grown in rotation, the comparative plant food requirements of these crops, their relation to the humus supply and other factors in the productiveness of the soil, and the comparative action of various fertilizing and other chemical elements on the different crop plants.

*Procedure.*—The work consists chiefly of field test plats on which the crops are grown in various combinations and in each case under different fertilizer or chemical treatments, together with such laboratory examination of the material as may be necessary.

*Cooperation.*—Bureau of Plant Industry, U. S. Department of Agriculture.

*Location.*—Upper Marlboro, Md.

*Date begun.*—1914.

*Results.*—The work will need to be continued for a series of years before final results can be expected, but marked differences in the yields of a given crop when grown after other crops which would occupy the same position in the rotation are being secured. For example, the effects of tobacco, potatoes and corn on yields of wheat, oats or rye following in the rotation have been quite different. Again, the effects of soy beans and cowpeas on tobacco have been decidedly different.

*Assignment.*—W. M. Lunn, D. E. Brown, J. E. McMurtrey, Jr.

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#### ANIMAL HUSBANDRY INVESTIGATIONS.

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##### SUPPLEMENTING WHOLE MILK IN RAISING CALVES.

*Object.*—An attempt to determine economical methods or method of raising calves where skim milk is not readily available.

*Procedure.*—Raising separate lots of 5 calves each to the age of 6 months on various milk substitutes, and checking the results by the raising of one lot on a standard commercial calf meal and one lot on whole milk.

*Location.*—Experiment Station.

*Date begun.*—August, 1917.

*Results.*—Four lots completed. Now being prepared to submit in form for publication. Four lots, as follows:

Lot I.—Schumacker calf meal.

Lot II.—Equal parts cornmeal, red dog, linseed, blood meal (the Purdue mixture).

Lot III.—Whole milk.

Lot IV.—Whole milk and water.

Show that addition of water to milk secures practically as good weights as either the Schumacker calf meal or the Purdue meal (red dog, corn meal, linseed meal (O. P.) and blood meal) which gave such striking results at Indiana, and that cost is considerably lowered.

*Assignment.*—R. C. Towles, under supervision Director Patterson.

#### ARMSBY HIGH AND LOW PROTEIN REQUIREMENTS.

*Object.*—To determine effect of the standard protein requirements versus the minimum plus 35 per cent. on growing animals.

*Procedure.*—Running the calves (3 or 4 mos.) in pairs, according to the outline of Dr. H. P. Armsby.

*Date begun.*—June, 1918.

*Results.*—Three pairs started. Two pairs discarded because of either lack of understanding of balancing the feeds or refusal of animals to eat. One pair carried over the required 6-month period. Show very slight difference in favor of the high protein ration. Will go on again this Fall, together with another pair.

*Assignment.*—R. C. Towles, under supervision Director Patterson.

#### COST OF MILK FROM FORCED vs. AVERAGED DAIRY CONDITION COWS.

*Object.*—To determine the cost of getting cows on the advanced register of their respective breeds.

*Procedure.*—To use 20 or more cows. Each cow to be forced and milked three times per day on one lactation and two times per day on another lactation, and productions to be interpolated to mature basis (5 yrs.) in terms of their respective association A. R. requirements for milk and fat.

*Location.*—Experiment Station.

*Date begun.*—September, 1917.

*Results.*—14 cows have been worked with. The first cow to complete a double record will be in November, 1919. Not any comparative data yet secured.

*Assignment.*—R. C. Towles, under supervision Director Patterson.

#### VALUE OF FLY REPELLANT (PINE-TAR CREOSOTE).

(Under supervision Mr. Cory. Continued by R. C. Towles during summers of 1918 and 1919.)

#### BEEF CATTLE FEEDING OVER THE STATE.

*Object.*—To observe methods and secure feeding and weight data.

*Procedure.*—To locate feeders who will record such data.

*Cooperation.*—Farmers in State.

*Location.*—Over the State.

*Date begun.*—1917.

*Results.*—Complete data from two feeders of one lot each.

*Assignment.*—D. G. Sullins, resigned; data recorded by R. C. Towles, supervised by Director Patterson.

## ABORTION OBSERVATIONS.

*Object.*—To determine whether or not wheat product feeds tend to develop the abortion bacilli and corn feed products foster the growth of the anti-bodies.

*Procedure.*—To discontinue heavy feeding of wheat products and to keep the corn product of the ration up to 20% when possible.

*Location.*—Experiment Station.

*Date begun.*—December, 1916.

*Results.*—Data from records on parturition during 18-month period of December 1, 1916, to June 1, 1918, when wheat products were fed heavily, show following:

Cows giving normal birth .....	22
Cows aborting .....	13

From June 1, 1918, to date the same data show following:

Cows giving normal birth .....	31
Cows aborting .....	4

*Assignment*—R. C. Towles, under supervision Director Patterson.

## 20% vs. 24% PROTEIN FOR DAIRY COWS.

*Object.*—To measure results in terms of lbs. of milk produced.

*Procedure.*—To use 6 cows first having 3 on low protein and 3 in high protein, and then to reverse, having a preliminary week and a feeding week, and securing data over 8 weeks of feeding.

*Location.*—Experiment Station.

*Date begun.*—June, 1919.

*Results.*—Completed. Show no difference in amounts of milk produced.

*Assignment.*—Dr. D. V. Meade, assisted by R. C. Towles.

## COCOANUT MEAL vs. GLUTEN FOR DAIRY COWS.

*Object.*—To measure results in terms of lbs. of milk produced.

*Procedure.*—To use 2 cows, first having 1 on cocoanut meal ration and 1 on gluten meal ration.

*Location.*—Experiment Station.

*Date begun.*—June, 1919.

*Results.*—Completed. Show that cocoanut meal is a very poor cow feed, which may probably be due to a mechanical trouble in that the cocoanut meal has a tendency to glue itself to the cows teeth.

*Assignment.*—Mr. J. A. Gamble, assisted by R. C. Towles.

## PLACING OF PURE BRED BULLS OVER THE STATE

*Object.*—To secure data on the value of pure bred bulls in grade herds, measuring results in terms of their heifer get.

*Procedure.*—To distribute the pure bred bull calves from our herd among farmers with the understanding that they save the heifer calves and in some instances keep milk records on dam and daughters. In order to secure such data it is advisable to generally place bull calves with members of regular cow testing associations.

*Location.*—Over the State.

*Date begun.*—Records show that bulls were placed with farmers as far back as 1911, but conditions were not favorable for securing good data until last four years.

*Results.*—14 mature bulls are now located under the plan, as well as 16 that have not reached breeding age. Two farmers have 13 daughters each from their bulls, and the other twelve all have 1 or more, in addition to neighborhood service.

*Assignment.*—R. C. Towles, G. E. Wolcott, supervised by Director Patterson.

## SWINE HUSBANDRY.

### PROJECT NO. 1: SWINE FEEDING EXPERIMENTS.

*Object.*—To determine the possibilities of using fish meal as a source of protein in feeding swine.

*Procedure.*—Two lots of pigs, of equal numbers and equal weight, to be given a carbonaceous feed—this to be balanced for one lot with tankage, and for the other lot with fish meal. This work to extend over several lots.

*Cooperation.*—U. S. Department of Agriculture.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—As far as the work has gone the fish meal has been equal to the tankage.

*Persons engaged.*—R. S. Allen.

### PROJECT NO. 2: SWINE FEEDING EXPERIMENTS.

*Object.*—To determine the value of some uncommon by-product feeds as a feed for swine.

*Procedure.*—The by-product to be worked into rations (suitable to the pigs at hand) from their chemical analysis, and fed against a ration made of standard hog feeds. The by-products on hand at present are: (1) Refuse popcorn; (2) semi-solid buttermilk; (3) cocoanut cake meal; (4) cocoa shell meal. Weights of animals and of feeds used to be kept. Not less than five animals to be used on a feed. Feeding period to be not less than sixty days. No publication to be made until a sufficient number of feeds have been tested to make a satisfactory compilation.

*Cooperation.*—None.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—To date, only the refuse popcorn has been tested; the results of this test were very satisfactory.

*Persons engaged.*—R. S. Allen, R. L. Grimes, H. J. Patterson.

### PROJECT NO. 3: SWINE HUSBANDRY FEEDING EXPERIMENTS

*Object.*—To determine the most profitable way of utilizing the corn crop as a feed for swine.

*Procedure.*—A given acreage of standing corn to be divided into three parts of equal size. Lot "A" to be fenced and hogs turned in on the standing corn. Lot "B" to be cut and hauled and fed stalk and all in dry lot. Lot "C" to be cut, shocked and husked, the corn alone being fed in dry lot. Tankage to be supplied by self-feeders to all three lots. Animals to be weighed at the beginning and end of each feeding period. Tankage consumed by each lot to be recorded. Time and expense of cutting and hauling the corn on Lot "B" to be recorded and the approximate loss of fodder. Expense of handling Lot "C" to be recorded, credit being given for fodder saved.

*Cooperation.*—Agronomy Department.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—

*Persons engaged.*—R. S. Allen, J. E. Metzger, H. J. Patterson.

### PROJECT NO. 4: SWINE FEEDING EXPERIMENT.

*Object.*—To determine the condition and profits in producing pork by the suburban residents in the backyard.



*Procedure.*—Full records are made of the conditions under which pigs are kept, kind and quantity of feed, time required for attention and gains made.

*Cooperation.*—County Agent and persons keeping pigs.

*Location.*—College Park, Md.

*Date begun.*—1918.

*Results.*—Small profits for feed consumed and ability to convert some waste products into pork.

*Assignment.*—R. S. Allen.

#### PROJECT NO. 5: SWINE FEEDING EXPERIMENTS.

*Object.*—To determine if cooked citrus fruit rinds have any poisonous or toxic effects on hogs. The work was conducted at the request of the Agricultural Committee of the National Research Council.

*Procedure.*—Lemon, orange and grapefruit rinds were cooked with a ration consisting of 94% cornmeal, 3% linseed meal and 2% tankage and fed to hogs in a pen where they had access to no other feed. The quantity of rinds was gradually increased until they represented one-third of the ration. The kinds of fruit were used by themselves, and each fed to special lots of hogs. There were three hogs in each lot.

*Cooperation.*—National Hotel, Washington, D. C.; Ebbitt House, Washington, D. C.; Orange-Ade Fountain, Washington, D. C.

*Location.*—College Park.

*Date begun.*—August, 1918, continued 90 days.

*Results.*—Proved not to be poisonous. Pigs made slight gains. Rinds have little food value. For details see Bulletin 227.

*Assignment.*—R. S. Allen, H. J. Patterson.

#### PROJECT NO. 6: SWINE BREEDING EXPERIMENTS.

*Object.*—To note the inadvisability of raising breeding stock from gilts.

*Procedure.*—A sow pig to be kept for breeding purposes from a gilt. The same gilt to be maintained in the herd until after she has had her fourth litter; a sow pig will then be taken from this litter and kept for breeding and compared with the sow from her litter as a gilt. This work to be continued over a lot of animals.

*Cooperation.*—None.

*Location.*—College Park, Md.

*Date begun.*—

*Results.*—

*Persons engaged.*—R. S. Allen.

#### PROJECT NO. 7: SLAUGHTER AND CURING OF MEATS.

*Object.*—To determine the most profitable way of disposing of hogs. Also, the shrinkage in curing.

*Procedure.*—Animals are weighed alive and the value of same made out. The animal is then slaughtered and the dressed carcass weighed and value rated. The carcass is then cut into retail pieces and their value estimated. The hams, shoulders and bacon are weighed and then cured; the trimmings made into sausage, scrapple, lard, etc. When the meat has been cured, the value is calculated; the four values are then in shape for comparison.

*Cooperation.*—None.

*Location.*—College Park, Md.

*Date begun.*—1916.

*Results.*—The indications are that with heavy hogs there is a slight advantage in selling the whole dressed carcass.

*Persons engaged.*—R. S. Allen.

## BIOLOGICAL LABORATORY HOG CHOLERA INVESTIGATIONS.

*Experimental Project 1* was outlined to obtain the percentage of double treated hogs that may later become susceptible to cholera; to find the proper age that pigs may be immunized by the double treatment; to find the length of time the immunity of double treated pigs may be expected to last.

The technic in this experiment consists of vaccinating pigs at varying ages by the simultaneous method. The animals are then exposed to hog cholera infection at various ages from six months to two years.

The work on this project has been conducted entirely at the Experiment Station, as it is not advisable to do it in the field.

The first animals were treated on January 15, 1919, and to date we have complete results on twenty-nine (29) animals. There are thirty-two (32) hogs under treatment at this time. This makes a total of sixty-one (61) animals. It is impossible to draw any conclusions at this time, as we do not have a sufficient number of completed results.

*Assignment.*—E. M. Pickens, C. C. Shivers, M. F. Welsh, R. S. Allen and K. Menzel

*Project 2* was undertaken to determine the age at which pigs from immune mothers become susceptible to hog cholera.

The plan of attack was to expose pigs to cholera by the administration of virus. The pigs to be treated varying from shortly after birth to the age at which they are found to be universally susceptible. The pigs which do not survive the inoculation may be considered susceptible.

This experiment, like Project No. 1, has been carried on entirely at the Experiment Station, as it is not wise to do this work in the field.

The project was started March 8, 1919, and to date we have complete results of forty-one (41) animals. There are thirty-two (32) pigs under observation on this experiment at the present time.

*Assignment*—E. M. Pickens, C. C. Shivers, M. F. Welsh, R. S. Allen and K. Menzel

*Biologics.*—Anti-hog cholera serum, virus, thermometers, syringes, and disinfectant have been distributed to the farmers of the State, but due to a great deal of cholera, in much larger quantities than usual. We were fortunate, however, in being able to contract for our supply of serum last spring at low prices and furnish it to farmers at retail at one and one-fourth cents ( $1\frac{1}{4}$ c.) per c.c., while the market price during the year has been from one and three-fourth ( $1\frac{3}{4}$ c.) to two and one-half ( $2\frac{1}{2}$ c.) per c.c.



The following table gives the amounts of these commodities distributed by counties from October 1, 1918, to September 30, 1919:

<i>County.</i>	<i>C. C. Serum.</i>	<i>C. C. Cresol.</i>	<i>C. C. Virus.</i>	<i>Thermo Syringes.</i>	<i>metres.</i>
Allegany					
Anne Arundel .....	20,050	1 gal.		7	6
Baltimore .....	1,800	2 "			
Calvert .....	21,250	2 "		4	3
Caroline .....	900				2
Carroll.....					
Cecil .....	4,000	2 "	95		
Charles .....	27,825	6 "		6	4
Dorchester .....	89,500	4 "		21	2
Frederick .....	8,800				
Garrett .....	3,500				
Harford .....	2,250	2 "			
Howard .....	20,950				
Kent .....	83,300	5 "		10	1
Montgomery .....	58,025	10 "	500	2	1
Prince George .....	39,800	21 "	15	12	14
Queen Anne .....	26,800	1 "			
St. Mary's .....	83,420	4 "	765	11	11
Somerset .....	143,875	2 "		22	14
Talbot .....	34,450		50		
Washington .....	21,300				
Wicomico .....	55,250			5	
Worcester .....	42,550			16	
Out-of-State .....	27,725	3 "	420	3	1
Live Stock Sanitary Board ....	471,250		3,786	1	1
Totals.....	1,288,570	65 gal.	5,631	120	60

## POULTRY DEPARTMENT INVESTIGATIONS.

### EGG HATCHING INVESTIGATIONS.

*Object*.—To determine the length of time eggs may be kept for purpose of incubation. To study the effects of different methods of handling eggs previous to incubation.

*Procedure*.—1. During the incubation season each egg intended for hatching purposes is marked with pen number and date and a record is kept of the results of incubation.

2. Eggs being saved for incubation are kept under different conditions and a record of their hatchability made.

*Cooperation*.—With practical poultry raisers.

*Location*.—College Park, Md.

*Date begun*.—1910.

*Results*.—1. All records from 1910 to 1913 inclusive were destroyed by fire. A digest of the records of 26,415 eggs shows that the eggs deteriorate directly with their age and that the loss becomes serious after about the twelfth day.

2. Eggs turned daily before incubation did not hatch better than similar eggs not turned.

*Assignment*.—Roy H. Waite.

# POULTRY FEEDING.

*Object.*—To devise a simple ration for poultry feeding.

*Procedure.*—Pens are fed different rations for comparison. Products produced on Maryland farms are given preference. Egg laying records and hatching records are kept. Individual hens are kept in a laboratory under closely controlled conditions and careful records made. Field damaged wheat is being compared with normal wheat. A comparison of the profit made from feeding capons *vs.* cockerels is being made.

*Cooperation.*—With practical poultry raisers as seems desirable.

*Location.*—College Park, Md.

*Date begun.*—1910.

*Results.*—Records from 1910 to 1913 inclusive were destroyed by fire. Rations composed of corn and corn products, wheat and wheat products when combined with meat feed of some kind were found to compare favorably with more complicated rations. Eggs from meat-fed hens hatch as well as from non-meat-fed hens, providing other conditions are the same. The amount of winter laying determines to a large extent the hatchability of eggs. Properly handled, field damaged wheat has compared favorably with normal wheat when fed exclusively to individual hens of two breeds over a period of six weeks. Twenty-one cockerels have eaten practically as much feed as twenty-one capons of same age and breed and both pens have made same gain. Bulletin 231, "Field Damaged Wheat for Poultry" now in press.

*Assignment.*—Roy H. Waite.

# GAPE WORMS IN POULTRY.

*Object.*—To determine method of transmission and find a remedy.

*Procedure.*—Chicks are given the disease under closely controlled conditions. When the exact method or methods of transmission are learned, devices for the prevention of infection will be sought.

*Cooperation.*—With practical poultry raisers.

*Location.*—College Park, Md.

*Date begun.*—1917.

*Results.*—It has been found that earth worms from soil on which infected flocks are yarded give the disease to young chicks and carry the disease over winter.

*Assignment.*—Roy H. Waite.

# APPLIANCES AND METHODS.

*Object.*—To devise and improve poultry equipment and methods used in handling poultry.

*Procedure.*—Devices and methods are improvised and improved as the work of the plant requires or as an opportunity presents itself.

*Cooperation.*—With practical poultry raisers.

*Location.*—College Park, Md.

*Date begun.*—1910.

*Results.*—A method for determining which hens are laying published in Bulletin 221, September, 1918. This bulletin was published in full in poultry journals. How to Caponize—Bulletin 226, February, 1919—re-published in full in six poultry journals. Poultry Appliances and Methods, Bulletin 230, August, 1919. Other information accumulated for publication at opportune time.

*Assignment.*—Roy H. Waite.

## PLANT PHYSIOLOGY INVESTIGATIONS.

*Project.*—The spindling sprout disease of potato tubers.

*Object.*—To study the nature and cause of this disease with the view of preventing the great losses in yield due to this disease.

*Procedure.*—It was first necessary to establish the non-parasitic character of the disease before it could be definitely classed as a physiological or nutritional disease. This being established, a physiological and biochemical study of the diseased tubers is being made in order to determine the nature of the pathological physiology in these tubers. A second point of attack is a study of the conditions responsible for this abnormal physiology. To this end many attempts are being made to produce the disease in normal tubers by artificial treatments. Some field studies are also being made in connection with the latter phase of the problem.

*Cooperation.*—Informal cooperation with the Department of Vegetable Culture.

*Location.*—College Park.

*Date begun.*—1910.

*Results.*—The non-parasitic character of the disease has been definitely established. It has not been possible to transmit the trouble from diseased to healthy tubers. Many observations have been made which contribute much to the recognition of various stages and degrees of severity of the disease. Considerable progress has been made in locating the physiological disturbance, and much light has been thrown on the cause of the trouble by several successful attempts in producing the disease by artificial means. A summary of a paper presented at a conference on degeneration diseases of potatoes, held on Long Island in July, 1919, will be published in the Proceedings of that Conference.

*Assignment.*—Chas. O. Appleman.

*Project.*—Physiological and biochemical studies with sweet corn.

*Object.*—1. To determine at different storage temperatures the rate of sugar depletion in green sweet corn after it is pulled from the stalk.

2. To study the chemical changes in the corn while ripening on the stalk, with the view of determining the effect of climate and other factors on the rate of these changes. This data will be of practical value in giving the approximate range of days under different seasonal conditions that corn may be pulled in the best condition for packing in cans or table use. The chemical changes during ripening are also being correlated with certain characters of the corn so that the chemical situation in the corn at different stages of maturity may be closely predicted by a mere inspection of these characters. The results of this study will be of value to those who are attempting to breed corn for high quality and also to those studying the effect of soil and other conditions on the quality of the corn, as they will furnish a basis for comparing analyses of ears at the same stage of maturity.

3. Chemical and physiological study of sweet corn dehydration.

*Procedure.*—A method is being used by which the rate of chemical changes in the corn under different conditions may be determined by comparing analyses from the same ear, thus avoiding false results obtained by comparing analyses of different ears. The analyses include the various carbohydrates, nitrogenous constituents, fat, crude fiber, ash, etc. Certain physiological processes, including respiration, are also being studied.

*Cooperation.*—None.

*Location.*—College Park, Maryland.

*Date begun.*—1917.

*Results.*—The following papers under this project have already been published: "Respiration and Catalase Activity in Sweet Corn," Amer. Jour. Bot., 5: 207-209, 1918; "Carbohydrate Metabolism in Green Sweet

Corn During Storage at Different Temperatures," Jour. of Agr. Res. 17: 137-152, 1919.

*Summary.*—The experimental work on the second part of the project is completed, but the data are not yet sufficiently organized to state definite conclusions.

*Assignment.*—Chas. O. Appleman, John M. Arthur and S. V. Eaton.

*Project.*—Effect of various storage conditions on the quality and seed value of root crops, with special reference to potatoes.

*Object.*—Potatoes and other root crops are living things in which living processes are continually going on. These processes or changes in tubers and roots, if allowed to proceed too rapidly, greatly impair their quality for both food and seed. The main object is a study of various storage conditions on the keeping qualities of these crops.

*Procedure.*—The crops are stored under controlled conditions and the effects of these conditions on keeping qualities of the crop determined by measurements of the rate of various physiological processes and by a chemical analyses and seed tests.

*Cooperation.*—Informal cooperation with the Department of Vegetable Culture.

*Location.*—College Park.

*Date begun.*—1912.

*Results.*—The results so far on this project concern the controlling influence of temperature, moisture and various ratios of carbon dioxide and oxygen on the physiological processes in potato tubers during storage. Preliminary results are published in Bulletins Nos. 167 and 191. Some of the most important unpublished results show that there is a very great deterioration in the seed value of potatoes when they are kept at cold storage for a long period after they have emerged from their rest period. The poor keeping quality of potatoes after a period of cold storage has been found to be due largely to very high respiration in the tubers for a time after they have been brought from cold storage. Two products of respiration are moisture and heat. The accumulation of these products around the tubers, especially under conditions of poor ventilation, greatly facilitate the growth of decay organisms. The degree of ventilation has also been found to greatly influence the chemical changes in potato tubers during storage.

*Assignment.*—Chas. O. Appleman, John M. Arthur.

*Project.*—Regeneration in potato tubers.

*Object.*—To study the effect of internal and external factors on production and growth of sprouts on potato tubers with the view of furnishing a scientific basis for the practical preparation of potatoes for seed and to throw light on some fundamental problems of plant growth in general. The relation of vitamins to plant growth is being especially emphasized in this connection, also the influence of apical dominance and the mechanism of its operation.

*Procedure.*—By chemical analyses and physiological studies an attempt is being made to locate the limiting factor or factors for sprout growth on seed pieces cut too small or of unfavorable shape. The weak sprouts are also being grown in a medium supplied with various substances, including water soluble vitamins. The same method is being applied to weak sprouts grown on whole tubers which have been subjected to different artificial treatments. Tubers of different varieties are being subjected to various storage treatments and then sprouted under different controlled conditions. Some of the laboratory and greenhouse results are being tested under field conditions.

*Location.*—College Park.

*Date begun.*—1916.



*Results.*—One phase of the problem is published in Bulletin 212. A preliminary report of another phase was published in Science 68: 319-320, 1918. Some unpublished results of more or less practical value are as follows: The vigor of the sprout determines the vigor of the plant and yield of tubers, all other conditions being equal. The vigor of the sprouts depends upon various internal and external conditions, many of which can be controlled in the practical handling and preparation of potatoes for seed. A method has been devised by which the normal vigor of a potato sprout for a given variety under normal growing conditions can be expressed in mathematical terms. This furnished a safe basis for comparing sprout vigor. In the varieties studied it has been found that the number and distribution of the first generation of sprouts, produced under favorable growing conditions is a good indication of the relative seed value of the tubers.

*Assignment.*—Chas. O. Appleman, John Paul Jones.

*Project.*—Behavior of potatoes in the ground during the growth of the plant and after the death of the vines by natural causes or by frost or other injury.

*Object.*—(1) To establish a chemical and scientific basis for maturity in potatoes. (2) To determine if there is any movement of reserve materials from the vines to the tubers after the death of the leaves by frost or other injury. (3) To determine at what stage in the history of the plant the leaves lose their power to synthesize carbohydrates and to mobilize the same in the tubers. This stage is reached before the destruction of the chlorophyll. (4) To study the changes in potatoes after the death of the vines by frost.

*Procedure.*—Laboratory and field work.

*Date begun.*—1918.

*Results.*—The increase of the total yield in the hill ceases at quite a well defined point in the history of the plant. Considerable data on maturity in potatoes is being accumulated. This should be of some practical importance at this time on account of recent agitation on the use of immature potatoes for seed. There seems to be no uniform standard among these advocates for immaturity nor do they seem to have any very definite idea of what they mean by immaturity. The so-called after-ripening processes which occur in potatoes after they are dug are entirely ignored.

Some important observations have been made in the changes in McCormick potatoes after the vines have been killed by frost. The growth processes continue in the underground part of the plant for some time after the vines have been killed by frost. Since the leaves are no longer able to manufacture organic food, the large tubers become mother tubers for the growth of the very small tubers, which normally are aborted and do not develop. The result is the multiplication of small tubers at the expense of the large tubers. Small tubers are sometimes formed on the surface of the large ones, making a rough product. The practical application of this discovery consists in getting the potatoes out of the ground as soon as possible after a killing frost.

*Assignment.*—Chas. O. Appleman, E. V. Eaton, S. V. Miller.

*Project.*—A study of the behavior of fruit buds and twigs of the peach during winter and spring, with special reference to hardiness.

*Object.*—The immediate aim of this project is to discover some of the main relations between the development of buds into fruit and the climatic or environmental conditions under which the fruit is grown. The ultimate object is to develop cultural methods and practices that will insure greater returns to the peach industry of the state by minimizing the amount of winter and spring frost injury to this important crop.

*Procedure.*—A bud or twig containing less concentrated sap than another bud or twig is more easily injured by cold if all other conditions are equal.



The first step in this work is to determine the water relations existing in different varieties of peaches during the winter and spring. A knowledge of the season when roots absorb most water from the soil and of the movement of water from twig to bud will throw much light on orchard cultivation practices. A study of the water content of buds and twigs is therefore being made from month to month in a number of varieties. After the water relations have been investigated, those of temperature will be taken up.

*Location.*—Peach orchards of the Maryland State College and Agricultural Experiment Station, College Park, Md.

*Date begun.*—This phase of the work was started in 1918.

*Results.*—The results of the work of last year are given in detail in an article entitled "An index of hardiness in peach buds" now in press. These results have also been noted in the annual report to the Director of the Experiment Station. One of the main observations brought out, and perhaps a rather important one, is that a variety of peach considered hardy had a lower moisture content value than one considered less hardy. This information, together with that of the seasonal rate of change in moisture content, may prove an important index in determining the varieties best suited for a given locality.

*Assignment.*—Earl S. Johnston.

*Project.*—Salt nutrition requirements of the potato plant.

*Object.*—This project has for its object the determining of the best proportions of chemical elements and compounds for the greatest production of the potato. A knowledge of the most economical ways of mixing fertilizers and at the same time producing a maximum yield is greatly needed, especially at a time when fertilizer materials are scarce and high priced. A well established, quantitative knowledge of the nutrient requirement of the potato plant will add materially to the general subject of plant nutrition. This phase of physiology has been considered so important that the National Research Council has appointed a special committee on salt requirement of agricultural plants. Although the present work of the committee is confined to a study of spring wheat and soy beans, yet there is need that a beginning be made in this sort of study with an entirely different type of plants such as the potato, one of the most important crops of Maryland.

*Procedure.*—The approved methods of studying plants in water and sand cultures will be followed in this work as far as possible.

*Location.*—Maryland Agricultural Experiment Station.

*Date begun.* 1919.

*Results.*—The results of the preliminary work are set forth in an article entitled "Nutrient requirement of the Potato Plant," now in press.

*Assignment.*—Earl S. Johnston. Co-operation of Dr. C. O. Appleman.

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## PLANT DISEASE INVESTIGATIONS.

### PROJECT I.: TOMATO BLIGHT.

*Object.*—To study the life history of *Septoria Lycopersici*, the pathogen of this disease, especially to determine how it survives the winter, the source of the first summer infection, and conditions tending to render the tomato plant susceptible or resistant to the disease.

*Procedure.*—The development of the fungus studied throughout the year in field, laboratory and greenhouse cultures, and inoculation of tomatoes made under different environmental conditions.

*Cooperation.*—At first with Bacteriological Department in preparation of culture media. Throughout with vegetable investigations in growing plants in field and greenhouse.

*Location.*—Experiment Station.

*Date begun.*—1914.

*Results.*—The common conidial form is the only stage that exhaustive work has revealed; it withstands temperatures near zero and has been found alive on tomato waste in the spring. Rain and wind and cultural methods are prominent factors in spreading the disease. High temperature and humidity favor infection. Certain varieties in the seedling stage, at least, seem more susceptible. Plants from frames and greenhouses may be the first source of infection in a field. Lack of nutrition and wet soil favor infection. Many other relatives of the tomato, especially horse-nettle, eggplant, and potato are affected by the same fungus.

Practical results have been published in Horticultural Society Reports, and other phases in reports of technical societies, and a monographic treatise on the parasite and the disease is about ready for publication.

*Persons engaged in the work.*—J. B. S. Norton and assistants.

### PROJECT III.: EFFECT OF SULFUR ON CELL STRUCTURE.

*Object.*—To determine the changes in plant cells of selected crops when grown in soils containing excess of sulfur or sulfur compounds, especially the effect on the nucleus.

*Procedure.*—Mustard, soy beans and other crops are grown on sand with definite nutrient solution applied with the addition of various proportions of sulfur. Fresh and fixed material from these cultures studied microscopically.

*Cooperation.*—On methods with Soils Department.

*Location.*—Md. Experiment Station.

*Date begun.*—1914.

*Results.*—Plans have been worked out, apparatus prepared and cultures grown and material fixed for study. The resignation of two fellows engaged at different times on this work and war conditions have delayed progress.

*Persons engaged.*—J. B. S. Norton, W. P. Snyder, C. E. Leathers.

### PROJECT IV.: SCLEROTINIA FRUIT ROT.

*Object.*—To work out the life history and limitations of the fungus forms Sclerotinia and Monilia causing diseases of fruits, especially their relation to blossom blight of fruit trees.

*Procedure.*—These fungi from many locations and many different hosts are studied under different conditions in field and laboratory and cross inoculations made and blossoms inoculated under different field and laboratory conditions.

*Cooperation.*—With bacteriologist at beginning in making culture media and with Station orchards in use of trees and fruit.

*Location.*—Md. Experiment Station and observations on orchards in various parts of the State

*Date begun.*—Present project outlined in 1914, based on previous investigations in 1902 and succeeding years.

*Results.*—Apothecial stage of Monilia of stone fruits discovered and account of same published in Science and in St. Louis Acad. Trans. in 1902. The susceptibility of a large number of different kinds of fruit to the brown rot fungus has been determined as well as the variation of the fungus on different hosts. The relative abundance of blossom blight and the apothecial stage has been determined, and it has been found that the petals and other parts of flowers affected by the ascospores may carry

the disease along to the stage when injured or ripening fruits may be attacked. *Sclerotinia* of huckleberry fruits and of other wild plants have also been studied. A paper on the variation in size and color of spores of *Sclerotinia cinerea* on different kinds of fruits has been published.

*Persons engaged.*—J. B. S. Norton.

#### PROJECT V.: FUSARIUM WILT RESISTANT TOMATOES.

*Object.*—To secure strains of canning tomatoes that will yield well on land infected with the wilt fungus prevalent in Maryland.

*Procedure.*—Many tomato varieties grown on wilt-infected soil and the varying yield and per cent. of diseased plants determined. Selections of the most healthy plants in badly diseased fields made and seed of these planted on infected soil and selections of the best yielding and most disease-free kinds made for a series of years. Continued field test of resistant kinds.

*Cooperation.*—With Mr. Rieck, of Preston, Geo. M. Osborne and Brothers, of Hurlock, and other farmers in wilt-infected soil for the tests; with U. S. Department of Agriculture, furnishing them selections for further trial, they furnishing cultures of *fusarium* for infecting test fields; and with Extension Service in distributing seed to farmers.

*Location.*—Md. Experiment Station, Preston, Hurlock, Ridgely and other Maryland locations.

*Date begun.*—1912.

*Results.*—Strains of good yield and quality and which give a good crop on infected land have been secured and are now in use on many Maryland farms. In 1919, 76 pounds of seed was distributed free to more than 2,000 persons. Further selections of these strains are being disseminated by the U. S. Department of Agriculture in other States. One strain in use is from the Greater Baltimore variety and the other is of the Stone type but of better quality. Results published in Bulletin 180, Reports of Md. and Peninsula Hort. Societies, etc.

*Persons engaged.*—J. B. S. Norton, C. E. Temple and assistants.

#### PROJECT VI.: MARYLAND GRASSES.

*Object.*—To prepare a manual of the wild and cultivated grasses of Maryland by which they can be identified and their economic value determined.

*Procedure.*—Grasses are collected from all parts of the State and herbarium specimens of them prepared. These are used to determine the species within the range of the State, the names and classification of the same. Plots of useful grasses are grown and the best use of these and wild ones in the field determined.

*Cooperation.*—With Agronomy Department on economic phase, and to some extent with United States Department Agriculture agrostologist in naming specimens.

*Location.*—Md. State College and all over the State.

*Date begun.*—A grass garden was begun in 1889 and again in 1893. One summer was spent in collecting grasses in 1907 and the systematic work done at intervals since then.

*Results.*—Several thousand specimens have been collected, from which the names and distribution of the grass species of the State have been worked out. Much information on the uses of these has been collected.

*Persons engaged.*—A. J. Hayward, 1889-91, grass garden; R. H. Miller, 1893, etc., grass garden; W. T. L. Taliferro, 1899-1906; P. M. Novik, 1907-8, collecting and identifying grasses; J. B. S. Norton, 1908 to date; S. D. Gray, 1914.

## PROJECT VIII.: MARYLAND TREES.

*Object.*—To prepare a manual of the trees, wild and cultivated, grown in Maryland.

*Procedure.*—The trees found in the State are listed, photographed and specimens taken for preservation and further study; from this information the distribution and other information desired is worked up.

*Cooperation.*—With the State Forester and U. S. National Herbarium.

*Location.*—Md. State College, forest regions and plantings of trees in the State, State Forester's Office.

*Date begun.*—Material has been collected by botanical staff and State Forester for many years; plans for collecting it into a bulletin were made in 1918.

*Results.*—Material gathered as indicated above and partly written up.

*Persons engaged.*—J. B. S. Norton, F. W. Besley.

## PROJECT IX.: DISEASES OF SEEDS.

*Object.*—To procure information that will aid in producing healthy crops by beginning at the source, the seed, especially to find the diseases that are carried in the seed and means of disinfecting seed carrying parasitic diseases, and to study the troubles due to immaturity.

*Procedure.*—Seeds collected from diseased plants, and parasites isolated from such as have them, diseased and immature seed grown to find whether they produce diseased offspring with or without treatment with disinfectants.

*Cooperation.*—With various departments and persons in supplying material and with Seed Laboratory in germinating samples.

*Location.*—Md. Experiment Station.

*Date begun.* 1917.

*Results.*—Compilation of the literature with results of a number of minor investigations published as aid to the agricultural side of the war in Bulletin 216. Cabbage black leg treatment with hot water found to be effective. Very young and immature seed, in some cases only a few days from the blossom, were found to germinate both fresh and after drying.

*Persons engaged.*—J. B. S. Norton, C. E. Leathers, 1917, W. N. Ezekiel, 1918.

## PROJECT X.: IDENTIFICATION LABORATORY.

*Object.*—To identify samples of weeds, poisonous plants, ornamental plants, trees, wild plants, mushrooms, and other fungi; and to make diagnoses of plant diseases, for residents of the State and members of the staff requiring such information.

*Procedure.*—Specimens received are identified from experience and by aid of the herbarium and manuals, or in difficult cases in the U. S. National Herbarium. When necessary plant pathogens are isolated and cultivated in the laboratory.

*Cooperation.*—With all who wish to use the facilities offered.

*Location.*—Md. State College.

*Date begun.*—Has been continuous, so far as known, since the beginning of the Station.

*Results.*—Hundreds of samples passed on each year.

*Person engaged.*—J. B. S. Norton since 1901.

## PROJECT XI.: MYCOSPHAERELLA.

*Object.*—To study the life histories of the species of the fungus genus *Mycosphaerella*, which contains many parasites of cultivated plants, and to connect with the perfect forms the conidial stages not yet associated



with them. By these studies to furnish a basis for combatting plant disease and to establish a body of special knowledge on a large and important genus in which there is now no specialist known to be working.

*Procedure*.—Living material to be collected from all available sources and cultures of this on suitable media and on a great variety of host plants to be made. Study of literature and types in collections.

*Cooperation*.—With any one who will supply material and with institutions owning collections that need to be examined.

*Location*.—Md. Experiment Station, etc.

*Date begun*.—Preliminary plans made in 1916; project outlined and work begun 1919.

*Results*.—Work outlined and some material collected.

*Person engaged*.—J. B. S. Norton.

#### PROJECT XII.: CONTROL OF LEAF BLIGHT OF TOMATO.

*Object*.—To devise *practical* methods for controlling septoria leaf blight of tomato under *field* conditions.

*Procedure*.—Various liquid and dust sprays used in field tests, these chemicals being applied by field machinery, many acres being sprayed each year.

*Cooperation*.—With U. S. Department of Agriculture and with many farmers

*Location*.—Hurlock, Ridgely and a few other places in Maryland.

*Date begun*.—1915.

*Results*.—Liquid sprays are more promising than dust sprays. Of the liquid sprays used regular Bordeaux, 4-4-50 and 5-5-50, have equaled or surpassed all other sprays used, including those to which resinfish-oil soap was added as a sticker or spreader. It was found that fields could be sprayed throughout the season without the great mechanical injury to the plants that results under ordinary conditions, by planting the rows six feet apart; but if the plants are set three feet apart in the rows this will give the same number per acre as when set 4 x 4.

*Person engaged*.—C. E. Temple.

#### PROJECT XIII.: ROOT ROT OF PEAS.

*Object*.—To determine the causes and to select strains resistant to the disease.

*Procedure*.—(1) Isolating the casual organisms in the laboratory. (2) Selecting the healthiest plants from 30 diseased fields in different parts of the State, seed of all these being planted on badly infected fields and further selections made from the progeny.

*Cooperation*.—With Wrightson and Son, Easton.

*Location*.—Easton and Md. State College.

*Date begun*.—1917.

*Results*.—One selection gave 83 resistant plants in 1919, or 16%. The common stock gave none free from the disease and not more than 5% that made a crop.

*Persons engaged*.—C. E. Temple and W. N. Ezekiel.

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#### INSECT INVESTIGATIONS.

PROJECT NO. 1.—The Woolly Aphis.

*Object*.—To ascertain a method of control, especially applicable to trees in the nursery.

*Procedure*.—A lot of two-year-old trees were planted out, approximately one-half of which were infested with the pest. These were divided into three lots, to be dug after one, two and three years. These three plots were



again divided into two lots, one to receive one application, the other two applications per year and each of these were treated with four strengths of pine tar creosote emulsion, namely 5-8-15 and 20 per cent. solution. At the end of each year one lot was dug and notes made on the presence or absence of aphids and on the growth of the trees on both checks and infested trees.

*Location.*—College Park, Maryland.

*Date begun.*—1908.

*Results.*—8 per cent. emulsion applied twice a year has proved efficient in controlling the aphids and non-injurious to the trees except in a few cases where the ground was of such a character that the soil held the creosote and natural water around the tree practically throughout the year. Preliminary work was begun by T. B. Symons and conducted until 1912. The second phase, consisting of orchard work 1912-1914, was done by E. N. Cory and published in the *Journal of Economic Entomology*, Vol. 8, page 186. The third phase—nursery work began in 1915 and was completed in 1918.

*Persons engaged.*—E. N. Cory, O. I. Snapp, H. S. McConnell and C. B. Nickles.

PROJECT No. 4.—The Boxwood Leaf Miner. In abeyance owing to the lack of material.

PROJECT No. 5.—The Biology and Control of Dipterous Leaf Miners. In abeyance owing to the lack of material and the more pressing need of investigating other problems.

PROJECT No. 6.—The Biology and Economic Relation to Greenhouse Crops of Certain Mites.

*Object.*—To study the life history, morphology, control and the possible relation of the mite to the transmission of certain diseases found associated with the mite in the houses where the pest was first located.

*Procedure.*—The project was divided into two parts, concerned first with the binomics of the insect and second, its agency in disease dissemination. The greenhouse was kept stocked with plants, infested and clean and on these the life history, injuries and control were worked out. In the second phase, pure cultures of the principal disease, *Cercospora brunckii* were used in direct and indirect inoculation experiments and methods devised to ascertain the role of the mite together with the method of control of the disease.

*Cooperation.*—R. Vincent & Sons, White Marsh, Maryland.

*Location.*—College Park, Maryland.

*Date begun.*—1916.

*Results.*—The complete life history of the mite, its morphology, the extent and character of its injuries, its distribution in Maryland greenhouses and cultural and insecticidal methods of control were published in the Maryland Agricultural Experiment Station Bulletin 208, namely, *Tarsonemus Pallidus* Banks, a Pest of Geraniums.

The second year's work on the disease and the possible relation of the mite showed that the mite could not transmit the disease, but that conditions favorable to the multiplication of the mite were optimum conditions for the development of the disease. Cultural methods and propagation practices, including the dipping of the cuttings in Bordeaux will control the dissemination and development of the disease. This is reported in the Maryland Agricultural Experiment Station Bulletin, namely, *The Relation of Certain Greenhouse Pests to a Transmission of a Geranium Leaf-spot.*

*Assignment.*—E. N. Cory and Philip Garman

PROJECT No. 7.—Parts 3 and 4. The Life History and Control of the Red Spider and the Life History and Control of the Greenhouse Mealy Bug.

*Object.*—To study the life history of the pests involved under greenhouse conditions and to develop satisfactory methods of control.

*Procedure.*—The parts are studied separately by senior students working under the close supervision of the head of the department. Life history studies under controlled conditions with observations on the pests in their natural environment, together with experiments on new and promising insecticides make up the main lines of investigation. The morphology of the mite and the mealy bug are also studied.

*Location.*—College Park, Maryland.

*Date begun.*—1919.

*Results.*—Parts 1 and 2 have been published as Experiment Station Bulletins numbers 205, namely, "Fumigation of Greenhouses," and 206, namely, "The Hothouse Milliped."

*Assignment.*—E. N. Cory, T. L. Bissell and E. G. Hook.

PROJECT No. 9.—Comparative Insecticide Tests.

*Object.*—To study the lethal effect of new insecticides on plant tissues.

*Procedure.*—Laboratory tests of new materials.

*Location.*—College Park, Maryland.

*Date begun.*—1915.

*Results.*—This project is being prosecuted as new material is forthcoming. In the past year a large number of new insecticides have been tested in the field and the results secured will form the basis of recommendations to the farmers of the State who request information in regard to any insecticide material.

*Assignment.*—E. N. Cory.

PROJECT No. 10.—Repelling Stable Flies. Temporarily in abeyance. Two years has been spent on this project and it is hoped that it can be taken up again next year, if sufficient help is available to carry out the work in the proper manner.

PROJECT No. 11.—A Study of *Laspeyresia molesta* Busck in Maryland.

*Object.*—To study the life history of a new and potentially dangerous imported pest of the peach and to develop methods of control.

*Procedure.*—The insect's life and seasonal history was studied under field and insectary conditions; the character and extent of injuries noted, the exact distribution learned; its morphology studied and compared with closely related species; the parasitism and methods of control worked out. The testing of control measures was continued in an orchard at Frederick, Maryland.

*Cooperation.*—The Federal Horticultural Board in the survey work and A. B. Routzahn an orchardist of Frederick.

*Location.*—College Park and Frederick, Maryland.

*Date begun.*—1916.

*Results.*—The complete life history and preliminary recommendations for control were published in Bulletin 209 of the Maryland Agricultural Experiment Station and the further experiments, together with the comparison with other species, were published in Bulletin 223 of the Maryland Agricultural Experiment Station, namely, "A Comparison of Several Species of Lepidoptera infesting Peach and Apple in Maryland, with additional notes on the Oriental Peach Moth." Work of this summer at Frederick and College indicates that an orchard may be protected by thorough spraying with a combination of self-boiled lime sulphur, nicotine sulphate and a satisfactory spreader, such as lime caseinate.

*Assignment.*—Philip Garman.

PROJECT No. 12.—Annotated list of the Halticini of College Park and vicinity.

*Object.*—To identify and list the flea beetles of College Park and vicinity and study their food plants.

*Procedure.*—The diligent collection of specimens and data on food plants; the subsequent determination of the species; the arrangement of synoptic tables of genera and species; and the preparation of a complete bibliography.

*Location.*—College Park, Maryland.

*Date begun.*—1912.

*Results.*—Forty-eight species of flea beetles were determined to be present in this faunal area. An annotated list with synoptic tables is now in press. A card index bibliography is on file in the office of the State Entomologist.

*Assignment.*—This project was begun by A. B. Duckett when a senior student under E. N. Cory's direction and finished later in his spare time when he was in the employ of the United States Bureau of Entomology. Mr. Duckett's untimely death in the influenza epidemic made it necessary for the Station Entomologist to prepare the manuscript in its final state for posthumous publication.

PROJECT No. 13.—Winter Protection of Bees.

*Object.*—To ascertain a method of protection which will be practical for the average farm and which will at the same time meet the requirements of temperature as ascertained by the Bureau of Entomology.

*Procedure.*—Packing of colonies in different hives at the College apiary. Notes were made of the conditions in the fall and spring.

*Location.*—College Park, Maryland.

*Date begun.*—1917.

*Results.*—No satisfactory recommendation may be made at this time.

*Assignment.*—E. N. Cory and G. H. Cale.

PROJECT No. 14.—Maintenance of Bees in Greenhouses.

*Note.*—Discontinued owing to the lack of cooperation of the parties with whom the project was begun.

PROJECT No. 15.—The Study of Biology and Control of the Rose Midge.

*Note.*—This project was a cooperative agreement between the Bureau of Entomology and this Department, and the results were published in Bulletin No. 778 of the Bureau of Entomology.

PROJECT No. 16.—Control of Insect Pests of Growing Crops, Stored Products and Live Stock with Special Reference to the Immediate Increase and Conservation of Food Products.

*Note.*—This project was a war emergency endeavor conducted in a large measure out of funds furnished by the State Council of Defense.

PROJECT No. 17.—Bionomics and Control of the Corn-root Aphis.

*Note.*—This project has been merged, at the suggestion of the Office of Experiment Stations, with Project No. 23, Part 1, entitled "Insecticide Investigation, sub-title, The Chemical and Physical and Insecticidal properties of commercial pine oils and creosotes."

PROJECT No. 18.—The Toxic Reactions of the Peach Tree Borer As Affecting Control.

*Object.*—To ascertain the color reactions of adult peach tree borers.

*Procedure.*—The primary colors, together with black and white, were painted on peach trees to ascertain the effect upon the oviposition of the peach tree borer.

*Location*.—Edgemont, Maryland.

*Date begun*.—1918.

*Cooperation*.—S. N. Loose, Edgemont, Maryland.

*Results*.—The two seasons work is inconclusive, although with enough promise to warrant their continuation. Work will also be prosecuted in the laboratory if conditions there are favorable.

*Assignment*.—E. N. Cory and C. B. Nickels.

PROJECT No. 19.—Biology of *Pollenia rudis*.

*Note*.—This project has been outlined but never been started owing to lack of properly qualified assistants to take up the work.

PROJECT No. 20.—Dusting Peach and Apple Trees for the Control of Insects and Diseases.

*Object*.—To ascertain whether dusting is an effective method of controlling insects and diseases of apple and peach.

*Procedure*.—The dusting of commercial orchards with various insecticides and fungicides. The securing of records on the condition of the trees and fruit after experiments have been conducted for two years.

*Location*.—Easton and Hancock, Maryland.

*Date begun*.—1918.

*Cooperation*.—W. M. Shelan, Tonoloway Orchard Co.; E. H. Snivly and County Agents Smith and Walls, together with cooperation from Prof. C. E. Temple, State Pathologist, and Mr. R. E. Cooly, Dr. Berger from the office of Market Fruit Investigations.

*Results*.—Two years' work indicates that insects may be controlled about as well as with average spraying, but that the diseases are not so easily checked.

*Assignment*.—E. N. Cory and W. C. Travers.

PROJECT No. 21.—Dusting Strawberry Fields to Control the Strawberry Weevil.

*Object*.—To ascertain the best combinations of dusting materials to control the strawberry weevil.

*Procedure*.—Dusting of plots on a commercial scale with different mixtures and securing records of yields from these plots and the untreated checks.

*Location*.—Ridgely and Marion, Maryland.

*Date begun*.—1918.

*Cooperation*.—Ridgely Sub-station, Paul Gunby and County Agents Anderson and Keller.

*Results*.—No appreciable difference between the different dusts could be observed and since the standard 85-15 is fully effective, the project will be discontinued and all efforts directed toward demonstration work with the 85-15 mixture.

*Assignment*.—E. N. Cory and W. C. Travers.

PROJECT No. 22.—Control of the Strawberry Aphis.

*Note*.—This project has not been started owing to lack of time.

PROJECT No. 23.—Insecticide Investigation. Part 1—The Chemical, Physical and Insecticidal Properties of Commercial Pine Oils and Creosotes.

*Object*.—To make available as a group such products as pine tar creosotes which preliminary experiments show to have considerable promise.

*Procedure*.—Chemical and physical studies in the laboratory on the creosotes and fractions secured by distillations, together with greenhouse and field tests of their insecticidal properties.

*Cooperation*.—Professor Broughton.

*Location*.—College Park, Maryland.

*Date begun*.—1918.



*Results.*—A considerable mass of data have been secured but which cannot be interpreted at this time. Insecticidal value of the creosotes runs high and there continues to be considerable promise in the material.

*Assignment.*—E. N. Cory, Philip Garman and C. B. Nickels.

PROJECT No. 24.—Bionomics and Control of the Apple Leaf-skeletonizer and the Bearing of the Data Obtained on Other Related Species.

*Object.*—To secure data on the apple leaf-skeletonizer and at the same time to get data on the meteorological conditions governing this and other related insects.

*Note.*—This project has not been started due to the resignation of Dr. Garman.

## PROGRAM OF WORK IN PROGRESS IN THE SEED LABORATORY.

### SEED INSPECTION.

*Object.*—To instruct the retail dealers of the State in regard to their responsibilities as defined by the State Seed Law and the rulings of the State Board of Agriculture as they apply to this act. To determine whether the seed offered for sale, or sold, within the State is tagged in accordance with the State Seed Law and is of guaranteed quality. To collect samples for analyses and germination tests.

*Procedure.*—At such times as the movement of seeds are heaviest an inspector visits the retail dealers, the railroad stations and the steamboat wharfs. Tagging is carefully noticed; necessary explanations of the law are made, and samples are taken and returned to the Laboratory.

*Cooperation.*—None.

*Location.*—All the principal points within the State where seeds are sold.

*Date begun.*—January, 1913.

*Results.*—Personal contact from one to three times each year with over two hundred retail dealers, and the collection of approximately fifteen hundred samples.

*Persons engaged.*—C. P. Smith, F. S. Holmes.

### ANALYSES AND GERMINATION TESTS OF COLLECTED (OFFICIAL) SAMPLES.

*Object.*—To determine whether the seed offered for sale or sold within the State is what the tags represent it to be. To inform dealers, farmers, and others of the quality of this seed through the publication of bulletins and other matter.

*Procedure.*—Collected samples are analysed and germination tests made in accordance with the rules of the A. O. S. A. N. A. and the results published as indicated. Violators of the law are notified directly as provided for in the State Seed Act.

*Cooperation.*—None.

*Location.*—College Park.

*Date begun.*—January, 1913.

*Results.*—A marked improvement in the quality of the seeds now sold as compared with those sold at the time the work was begun.

*Persons engaged.*—C. P. Smith, F. S. Holmes, C. R. Hodgins, A. M. Hook, C. F. Veitch.



## ANALYSES AND GERMINATION TESTS OF SUBMITTED (UNOFFICIAL) SAMPLES.

*Object.*—To provide firms and persons of the State with analyses and germination tests of such seeds as they may wish tested.

*Procedure.*—Samples are handled in the same way as those collected, only such data as is requested, however, being sent out. This is done within the shortest possible time.

*Cooperation.*—None.

*Location.*—College Park.

*Date begun.*—January, 1913.

*Results.*—During the past year approximately seven hundred samples have been analyzed or tested for viability as requested.

*Persons engaged.*—C. P. Smith, F. S. Holmes, A. M. Hook, C. R. Hodgins, C. F. Veitch.

# FINANCIAL STATEMENT.

## MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH UNITED STATES APPROPRIATIONS.

*Dr.**Hatch  
Fund.**Adams  
Fund.*

To appropriations for fiscal year 1918-1919.....	\$15,000.00	\$15,000.00
--	-------------	-------------

*Cr.*

By Salaries .....	\$11,173.32	\$10,948.31
Labor .....	2,653.30	230.83
Publications .....	418.69	—
Postage and Stationery .....	21.67	21.70
Chemicals and Laboratory Supplies .....	44.74	942.77
Seeds, Plants and Sundry Supplies .....	110.87	162.46
Library .....	27.11	—
Tools, Machinery and Appliances .....	9.72	584.97
Furniture and Fixtures .....	320.70	570.20
Scientific Apparatus and Specimens .....	215.08	1,376.38
Traveling Expenses .....	—	91.22
Contingent Expenses .....	4.80	6.60
Repairs .....	—	64.56
Totals.....	\$15,000.00	\$15,000.00

MARYLAND AGRICULTURAL EXPERIMENT STATION IN  
ACCOUNT WITH THE STATE APPROPRIATIONS.

<i>Dr.</i>		
	<i>General Fund.</i>	<i>Ridgely Farm.</i>
Balance June 30, 1918 .....	—	\$2,621.96 4,532.98
Receipts for year 1918-1919 .....	\$26,101.90	7,154.94
<i>Cr.</i>		
By Overdraft June 30th, 1918 .....	26.47	—
Salaries .....	9,957.31	1,605.00
Labor .....	4,082.43	915.80
Publications .....	2,692.19	—
Postage and Stationery .....	473.99	38.20
Freight and Express .....	800.26	22.14
Heat, Light and Water .....	810.84	15.36
Chemicals and Laboratory Supplies .....	185.40	—
Seeds, Plants and Sundry Supplies .....	1,576.89	290.07
Fertilizers .....	193.00	418.20
Feeding Stuffs .....	3,379.05	153.86
Library .....	250.59	—
Tools, Machinery and Appliances .....	2,162.44	472.56
Furniture and Fixtures .....	217.68	122.04
Scientific Apparatus .....	5.00	—
Live Stock .....	22.00	—
Traveling Expenses .....	509.65	18.41
Contingent Expenses .....	105.30	179.10
Repairs .....	523.27	330.70
Rent .....	145.00	—
Balance June 30th, 1919 .....	—	2,573.50
	<hr/> \$28,118.76	<hr/> \$7,154.94
Overdraft June 30th, 1919		
Due from State Treasurer for Expenses for June, 1919 .....	2,016.86	—

MARYLAND AGRICULTURAL EXPERIMENT STATION IN  
ACCOUNT WITH

<i>Dr.</i>		
	<i>Soil Fund.</i>	<i>Farm Fund.</i>
Balance June 30th, 1918 .....	\$6,544.09	\$1,332.79
Receipts for Year 1918-1919 .....	—	14,931.37
	\$6,544.09	\$16,264.16
<i>Cr.</i>		
By Salaries .....	\$4,308.03	\$898.29
Labor .....	639.87	10,783.31
Postage and Stationery .....	22.08	30.00
Freight and Express .....	12.52	268.51
Heat, Light and Water .....	—	209.53
Chemicals and Laboratory Supplies .....	358.68	73.97
Seeds, Plants and Sundry Supplies .....	113.80	219.99
Fertilizers .....	757.60	206.75
Feeding Stuffs .....	—	667.75
Tools, Machinery and Appliances .....	9.84	957.10
Furniture and Fixtures .....	—	11.50
Scientific Apparatus .....	87.60	—
Live Stock .....	—	45.00
Traveling Expenses .....	840.49	876.15
Contingent Expenses .....	—	83.77
Repairs .....	—	436.93
Rent .....	—	715.00
Insurance .....	—	2,779.90
Totals.....	\$7,150.51	\$19,263.45
Overdraft June 30th, 1919 .....	*606.42	2,999.29

\*Loan to College Fund year 1916-17 not paid when due on account of unusual expenses incident to war programme. Will be repaid Dec. 1st, 1919.

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